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Transmittal Letter

DATE: April 2, 2012 PROJECT NO. 3560.019

COMPANY NAME: Metropolitan Sewer District of Greater Cincinnati
ATTENTION: MaryLynn Lodor
ADDRESS: 1600 Gest Street
CITY/STATE/ZIP: Cincinnati, OH 45204
RE: Lick Run Comprehensive Design Report

WE ARE SENDING YOU:

- ☐ Change Order
- ☐ Drawings
- ☐ Samples
- ☐ Specifications
- ☐ Copy of Letter
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Signed Jeff Heimann
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Report for

Metropolitan Sewer District of Greater Cincinnati, Ohio

Lick Run Comprehensive Design

MSA No. 95X10595
Task Order No. 068090074

Prepared by:

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March 2012

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APPENDICES

EXECUTIVE SUMMARY

The *Lick Run Comprehensive Design Report* is intended to provide a summary document containing the evaluations and analyses conducted to date relating to the conceptual development and preliminary engineering of the proposed Lick Run Wet Weather Strategy that was developed in response to the regulatory requirements for the Metropolitan Sewer District of Greater Cincinnati (MSDGC) to reduce current levels of combined sewer overflows (CSOs).

MSDGC is under a United States Department of Justice (USDOJ) Consent Decree (referred to as Consent Decree) with United States Environmental Protection Agency (USEPA), Ohio Environmental Protection Agency (OEPA), and the Ohio River Valley Sanitation Commission (ORSANCO) (referred to as the Regulators) to minimize discharges from its combined sewer system (CSS). As part of this Consent Decree, the Regulators have mandated that MSDGC implement prescribed solutions to reduce the 14 billion gallons of combined sewer overflow (CSO) that annually discharge from MSDGC's CSS. In response, MSDGC has developed a two-phase Wet Weather Improvement Program (WWIP). Phase 1, which includes a variety of projects and strategies, must eliminate 2 billion gallons of annual CSO volume by the end of 2018.

Phase 1 of the WWIP developed by MSDGC, and submitted on June 4, 2009, includes the Lower Mill Creek Partial Remedy Project (LMCPRP), which specifically consists of a deep tunnel from Mill Creek WWTP to CSO 005, consolidation sewer from CSO 005 to CSO 009, and an Enhanced High Rate Treatment (EHRT) facility. However, Phase 1 also includes a three-year study and design period to examine alternative measures. Following this three-year study and design period, a "Revised LMCPRP" may be submitted to the Regulators as long as the proposed revisions provide an equal or greater level of CSO control and are able to be completed by the Phase 1 end date of December 31, 2018. The Revised LMCPRP must then be submitted by December 31, 2012.

As one of MSDGC's largest combined sewer overflow basins, CSO 005 is a major focus of Phase 1 of MSDGC's WWIP. This basin, also known as the Lick Run Watershed, is approximately 2,700 acres located within the Lower Mill Creek watershed on the west side of Cincinnati just north of the downtown area. CSO discharges from the Lick Run Watershed are estimated to be 1.5 billion gallons annually without including real time control (Systemwide Model (SWM) Version 3.1), accounting for more than 10 percent of MSD's total annual average overflow volume and the greatest source of CSO volume in the Lower Mill Creek watershed. The watershed characteristics and high CSO volume discharging from the Lick Run Watershed provided MSDGC with a unique opportunity to eliminate a significant percentage of CSO as stipulated in Phase 1 of the WWIP.

In June 2009, MSDGC engaged a project team to evaluate wet weather control strategies for stormwater management in the Lick Run Watershed with the ultimate goal of satisfying CSO control objectives. A four-step sustainable watershed evaluation process was used to develop a Lick Run Watershed Plan including an inventory and evaluation of existing conditions of individual drainage subbasins within the watershed, identifying sustainable strategies to effectively remove and/or delay stormwater from entering the CSS in each of these drainage subbasins, and selecting a recommended suite of projects for the Wet Weather Strategy in the Lick Run Watershed. Additional evaluation efforts to date include a number of reports, studies, and design documents examining existing physical, social, and economic conditions within the watershed, preliminary modeling, design, and costs, environmental assessments, transportation analyses, geotechnical exploration, and value engineering, all of which are discussed further in this report. The conclusions and recommendations for the Lick Run Wet Weather Strategy that evolved from the analyses and planning completed through these previous efforts have resulted in an approach consisting of two primary elements: strategic sewer separation and an urban valley conveyance system.

The strategic sewer separation element is comprised of 14 individual sewer separation projects totaling approximately 70,000 linear feet of new stormwater conveyance in both closed conduit and open channel designs. The valley conveyance system is approximately 1.5-miles long and consists of a hybrid closed conduit and open channel conveyance system, an open water forebay, an online stormwater pond, and structural best management practices. The new storm sewers and open channel systems will ultimately convey captured stormwater to the Mill Creek via the urban valley conveyance system. Refer to Figure ES-1 for a map of the recommended strategy.

The limits of the strategic sewer separation areas within the 2,700-acre watershed were determined with the goal of capturing as much stormwater as possible with strategic investments in new infrastructure. With that goal in mind, the sewer separation approach targeted stream entry points, large undeveloped hillsides, and areas already served by separate storm and sanitary systems that eventually discharge to the CSS. These targeted areas of the watershed are identified as “priority areas” and represent approximately 1,800 acres. Highly developed areas on the upper reaches of the watershed requiring extensive separation, and therefore expense, were excluded from the priority areas unless it was reasonably efficient to extend new separated storm sewers to connect with existing drainage systems. These upland areas are termed “non-priority areas” and represent the remaining 900 acres.

The strategic sewer separation is proposed primarily through the installation of new storm sewers or natural conveyance systems sized to convey stormwater from the priority areas only. As mentioned previously, there are 14 individual project areas with limits that were ultimately developed based on characteristics such as maintenance of traffic, location within the watershed, logical termini, and projected construction cost. Additionally, there are other non-linear elements proposed as a part of the sewer separation projects. These include detention basins and several small-scale site-specific controls, which provide water quality and water quantity benefits.

The urban valley conveyance system element will receive the stormwater runoff captured and conveyed from the strategic sewer separation areas, as well as overland flow that is expected to occur during large storm events, and will ultimately discharge these flows to the Mill Creek. The current 1.5-mile concept, referred to as the hybrid valley conveyance system, achieves anticipated hydraulic performance requirements while taking into account existing physical constraints within the conveyance corridor, and was developed to support MSDGC’s *Communities of the Future* initiative objectives. This concept is currently being presented at a series of community design workshops to solicit input from the community and will be incorporated into a Lick Run Master Plan that is anticipated to be completed in March 2012.

In January 2011, MSDGC conducted a *Value Engineering Study* (VE Study) on the recommended plan for the Lick Run Wet Weather Strategy described above. An independent team of consultants completed a detailed review of all the supporting documents, analyses, and modeling. While the team supported the overall strategy, the final report included recommendations for the sewer separation projects. The recommendations focused primarily on sizing the new storm sewers for a typical annual storm event or performing partial separation for the entire watershed and not just the priority areas. After evaluating these recommendations, MSDGC decided to proceed with the strategic sewer separation approach.

The VE study also included recommendations for the urban valley conveyance system. These recommendations addressed issues including water quality, constructability, cost, maintenance, environmental factors and habitat, and community enhancements. MSDGC completed a preliminary evaluation of the recommendations and will further evaluate those ideas that may enhance the project during advanced design.

While the strategic separation projects will provide an immediate localized benefit upon implementation, the anticipated CSO reduction benefit is a result of the strategic separation projects in conjunction with the urban valley conveyance system. As of December 2011, the opinion of probable construction cost is approximately $52 million for the sewer separation projects at their various levels of design and approximately $67 million for the urban valley conveyance system. This results in a total opinion of probable construction cost of $119 million. The opinion of capital cost for the strategic separation projects, which includes approximately $1 million for easements and a number of other factors and contingencies, is approximately $67 million, while the opinion of capital cost for the urban valley conveyance system is approximately $97 million, including $14 million for property acquisition and a number of other factors and contingencies. This results in a total opinion of capital cost of $164 million. Construction and property costs for the strategic separation projects is approximately $53 million and approximately $81 million for the urban valley conveyance system. This results in a total opinion of probable construction cost and property cost of approximately $134 million.

The most recent modeling analysis of the recommended Lick Run Wet Weather Strategy using the system wide model was conducted in March 2010. This analysis indicated the Wet Weather Strategy would reduce the annual stormwater volume entering the combined sewer system by 1,036 million gallons, consequently reducing the annual CSO volume at CSO 005 by 823 million gallons (SWM 4.0). Based on the project costs previously provided, the resulting cost per gallon of CSO reduction for the Lick Run Wet Weather Strategy is $0.16 per gallon ($134 million divided by 823 million gallon reduction).

There are a number of key issues that will need to be addressed as the Lick Run Wet Weather Strategy moves forward, including historical and archaeological impacts, hazardous materials in the project limits, property acquisition and easement needs, maintenance of traffic, and permitting.

While these issues and risks will need to be resolved during detailed design, the viability of the strategy was confirmed by the VE team.

> "The approach being taken to control wet weather combined sewer overflows in the Lick Run catchment area by separating sanitary flows from storm water flows and reducing the amount of stormwater entering the sewer system through detention and infiltration appears to be sufficient to achieve the goal of reducing annual combined sewer overflows by 2 billion gallons and meet the USEPA consent decree. The stormwater capture predicted by the hydrology and hydraulics model that will occur when the strategy is implemented shows a reasonable percentage of stormwater capture. A review of the model reveals that its calibration with existing conditions is also reasonable, leading one to believe in the results of the model with the changes implemented."

The conclusions of the VE Study mirror the conclusions contained in previous planning and preliminary engineering studies and analyses, i.e., the Lick Run Wet Weather Strategy provides a reasonable and cost-effective solution for reducing current CSO from the Lick Run Watershed.

SECTION 1
INTRODUCTION

1.01 PURPOSE

The purpose of this *Lick Run Comprehensive Design Report* is to provide a summary document outlining the evaluations, analyses, results, and status of the proposed Lick Run Wet Weather Strategy. This report includes information relating to the project background and various planning, research, and design efforts for the two primary elements of the Wet Weather Strategy, namely, strategic sewer separation, and conveyance of stormwater in the central corridor between Queen City and Westwood Avenues, hereafter referred to as the urban valley conveyance system.

1.02 PROJECT BACKGROUND

A. Project Purpose and Need

The Metropolitan Sewer District of Greater Cincinnati (MSDGC) is under a United States Department of Justice (USDOJ) Consent Decree (referred to as Consent Decree) with United States Environmental Protection Agency (USEPA), Ohio Environmental Protection Agency (OEPA), and the Ohio River Valley Sanitation Commission ORSANCO (referred to as the Regulators) to minimize discharges from its combined sewer system (CSS). As part of this Consent Decree, the Regulators have mandated that MSDGC implement prescribed solutions to reduce the 14 billion gallons of combined sewer overflow (CSO) that annually discharge from MSDGC's CSS. In response, MSDGC has developed a two-phase Wet Weather Improvement Program (WWIP). Phase 1, which includes a variety of projects and strategies, must eliminate 2 billion gallons of annual CSO volume by the end of 2018.

Phase 1 of the WWIP developed by MSDGC, and submitted on June 4, 2009, includes the Lower Mill Creek Partial Remedy Project (LMCPRP), which specifically consists of a deep tunnel from Mill Creek WWTP to CSO 005, consolidation sewer from CSO 005 to CSO 009, and an Enhanced High Rate Treatment (EHRT) facility. However, Phase 1 also includes a three-year study and design period to examine alternative measures. Following this three-year study and design period, a "Revised LMCPRP" may be submitted to the Regulators as long as the proposed revisions provide an equal or greater level of CSO control and are able to be completed by the Phase 1 end date of December 31, 2018. The Revised LMCPRP must then be submitted by December 31, 2012.

As one of MSDGC's largest CSO basins, CSO 005 is a major focus of Phase 1 of MSDGC's WWIP. This basin, also known as the Lick Run Watershed, is approximately 2,700 acres located within the Lower Mill Creek watershed on the west side of Cincinnati just north of the downtown area. Figure 1.02–1 presents a location map for the Lower Mill Creek watershed within the City of Cincinnati. Figure 1.02-2 shows the Lick Run Watershed within the Lower Mill Creek Watershed and the overflow point at CSO 005. CSO discharges from the Lick Run Watershed are estimated to be 1.5 billion gallons annually without including real time control (Systemwide Model (SWM) Version 3.1), accounting for more than 10 percent of MSD's total annual average overflow volume and the greatest source of CSO volume in the Lower Mill Creek watershed. The watershed characteristics and high CSO volume discharging from the Lick Run Watershed provided MSDGC with a unique opportunity to eliminate a significant percentage of CSO as stipulated in Phase 1 of the WWIP.

Currently the Lick Run Watershed includes approximately 88 miles of combined sewers that drain to a central 19.5-foot-diameter combined sewer pipe that conveys wastewater and stormwater runoff from the watershed. During dry weather, wastewater flow from the 19.5-foot-diameter combined sewer is conveyed through a 24-inch-diameter connection to the Auxiliary Mill Creek Interceptor that in turn conveys the wastewater to the Mill Creek Wastewater Treatment Plant (WWTP) for treatment before discharging into the Ohio River. During wet weather events, stormwater runoff overloads the CSS and triggers overflows directly to the Mill Creek through the CSO 005 outfall structure.

B. Project Groundwork

MSDGC has developed an initiative, known as *Project Groundwork*, focused on identifying and developing alternate approaches to installing traditional infrastructure to store, pump, and treat combined sewer flows. While MSDGC must reduce sewage overflows to meet the requirements of its Consent Decree, *Project Groundwork* also strives to implement sustainable solutions that enhance surrounding neighborhoods and promote positive economic activity. The *Communities of the Future* initiative applies this mission to problems specific to declining urban areas including redevelopment of brownfields, and property vacancy and abandonment. Improvements to existing sewer infrastructure (sanitary or storm), coupled with improvements to other utilities, transportation facilities, housing, and recreation facilities, can help address some of these problems. MSDGC is evaluating priority watersheds throughout its service area for opportunities to implement sustainable solutions to CSO control that also provide other community enhancements.

C. Lick Run Wet Weather Strategy

In June 2009, MSDGC engaged a project team to evaluate wet weather control strategies for stormwater management in the Lick Run Watershed with the ultimate goal of satisfying CSO control objectives.

A four-step sustainable watershed evaluation process was used to develop a Lick Run Watershed Plan including an inventory and evaluation of existing conditions of individual drainage subbasins within the watershed, identifying sustainable strategies to effectively remove and/or delay stormwater from entering the CSS in each of these drainage subbasins and selecting a recommended suite of projects for the Wet Weather Strategy in the Lick Run Watershed. Figure 1.02-3 is a graphical representation of the four-step process that MSDGC is utilizing in other watersheds as well.

Figure 1.02-3 Recommended Sustainable Infrastructure Evaluation Process

Additional evaluation efforts to date include a number of reports, studies, and design documents examining existing physical, social, and economic conditions within the watershed, preliminary modeling, design, and costs, environmental assessments, transportation analyses, geotechnical exploration, and value engineering, all of which are discussed further in this section. The conclusions and recommendations for the Lick Run Wet Weather Strategy that have evolved from the analyses and planning completed through these previous efforts have resulted in an approach consisting of two primary elements: strategic sewer separation (see Section 2) and an urban valley conveyance system (see Section 3). While the foundation of the Lick Run Wet Weather Strategy is strategic sewer separation and an urban valley conveyance system, reforestation, detention, small-scale site-specific controls, and downspout disconnection are also elements in the overall integrated watershed plan. These elements have evolved over time to include more detail and refinement and are summarized in this report.

D. <u>Summary of Efforts to Date</u>

Since June 2009, the Wet Weather Strategy evolved from a conceptual plan to a technically feasible project with specific elements advanced to various levels of design. Efforts to date include technical reports, studies, memos covering a number of topics including, but not limited to, technical details and feasibility, stakeholder engagement efforts, hydrologic and hydraulic modeling, existing watershed conditions, soils investigations, opinion of probable costs, and a value engineering study.

1. Associated Reports and Supporting Documents

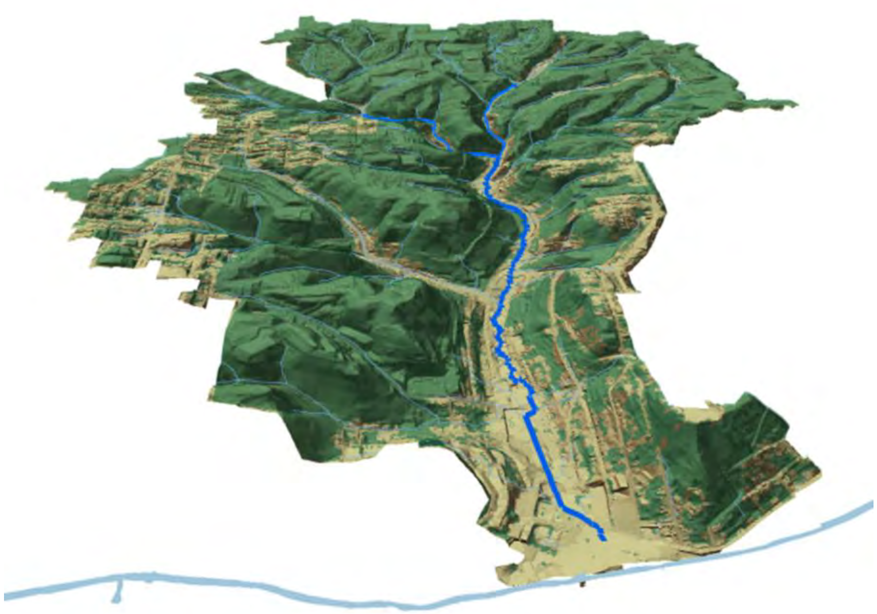
Individual technical reports and supporting documents have been prepared independently of this *Lick Run Comprehensive Design Report* and are listed below. Appendix A contains copies of these reports and supporting documents in their entirety.

a. Lick Run Conceptual Report

The August 2009 *Lick Run Conceptual Report* (Conceptual Report) was the first in a series of the Lick Run Wet Weather Strategy reports. The primary component of this report was an evaluation of natural systems, built systems, historical assets, and demographics within the watershed. Examples of this inventory include the natural drainage systems that once served this watershed, as illustrated in Figure 1.02-4. Figure 1.02-5 presents the modern day landscape, illustrating the natural drainage systems now piped through the CSS and the location of residential development on the outer reaches of the watershed.

The unique characteristics of the watershed, specifically large and steep undeveloped hillsides, poor infiltrating soils, and a relatively well-defined valley-shaped watershed provided the basis for the development of the Lick Run Wet Weather Strategy. The Wet Weather Strategy includes strategic sewer separation, an urban valley conveyance system, reforestation, detention, small-scale site-specific controls, and downspout disconnection.

The report included a brief results section highlighting preliminary benefits and costs of the Wet Weather Strategy.



Source: Human Nature, Inc.

Figure 1.02-4 Predevelopment Landscape Showing the Natural Systems

Source: Human Nature, Inc.

Figure 1.02-5 Present Day Development in the Lick Run Watershed

b. Preliminary Engineering Analysis-Hydrology and Hydraulics

The November 2009 *Preliminary Engineering Analysis–Hydrology and Hydraulics* (PEA) report was developed to provide a hydrologic and hydraulic foundation for the implementation of the Conceptual Report. One of the key technical issues resulting from the Conceptual Report was the feasibility of an open channel system located in the corridor between Queen City Avenue and Westwood Avenue to safely convey design storm flows to the Mill Creek. For the purpose of this analysis, it was assumed the urban valley conveyance system would be sized to convey runoff from the entire 2,700-acre watershed for flows up to, and including, the 100-year design storm. In reality, the CSS would continue to convey some portion of the runoff from the upland portions (approximately 900 acres) of the watershed, limited to the available capacity of these existing sewers for more frequent storm events.

The results of this analysis confirmed that there was, in fact, adequate space between the roadways to construct an urban valley conveyance system. The report also included drawings for preliminary storm sewer and valley conveyance system alignments and preliminary pipe sizing used to develop an updated cost opinion.

It was recognized that water surface elevations in the Mill Creek have the ability to impact the drainage system of the Lick Run Watershed, and the potential to create backwater conditions and or flooding in the urban valley conveyance system. Therefore, a coincidental storm condition was utilized to conservatively assess the hydraulic feasibility of the proposed system. In an effort to minimize risk of flooding, the discharge point of the proposed urban valley conveyance system was assigned an outlet elevation of 484. This represents the elevation of the Mill Creek when the Barrier Dam gates are closed and the pumps are activated, plus a 2-foot factor of safety. The proposed channel cross section was then sized to convey 100-year storm flows from the entire Lick Run Watershed.

c. Property Acquisition Plan

The October 2009 *Preliminary Property Acquisition Plan* identified preliminary properties that would potentially be impacted by implementing the conceptual urban valley conveyance system as identified in the PEA. This report provided a summary of the associated property information including parcel numbers, addresses, areas, zoning, and current valuations as well as a map book showing these prospective acquisition parcels in relation to the conceptual urban valley conveyance system. In developing the preliminary summary of property acquisitions, impacts to adjacent properties from the proposed channel area improvements were considered without regard to potential mitigation approaches. Where such impacts required a partial taking that appeared to compromise the full and unencumbered use of the remainder of property, the entire property was included as an acquisition. This resulted in approximately two-thirds of the properties in the corridor being identified for acquisition.

Figure 1.02-6 presents an overview of the properties included in the *Preliminary Property Acquisition Plan* as a result of implementing the conceptual urban valley conveyance system as the identified in the PEA.

Figure 1.02-6 Preliminary Property Acquisition Plan Overview

While the *Preliminary Property Acquisition Plan* identified properties that would be impacted by implementing the conceptual urban valley conveyance system concept as identified in the PEA further reports, studies, and design documents have been prepared resulting in evolving valley conveyance system concepts. With the evolution of valley conveyance system concepts, the property acquisition requirements in this corridor have been modified and more clearly defined. Each property under consideration for acquisition has been categorized and provided a technical justification based on one of the following criterias:

(1) Open Conveyance Only–Property is necessary for only the hybrid open channel and box conduit valley conveyance system concept.
(2) Closed Conveyance–Property is necessary for only a closed conduit valley conveyance system concept.
(3) Both–Property is necessary for either option (1) or (2) above;
(4) Interceptor for Both Options–Property is necessary for installation of a new storm sewer pipe, combined sewer pipe relocation, or water main relocation to accommodate either option (1) or (2) above.
(5) Design Flexibility–Property is not directly needed for options (1), (2), or (4) above, but has existing constraints that, if acquired, would provide design flexibility in the final valley conveyance system concept that could result in project cost savings.

Figure 1.02-7 presents an overview of the updates made to the *Preliminary Property Acquisition Plan* as a result of evolving valley conveyance system concepts and the technical justification classification assigned to each.

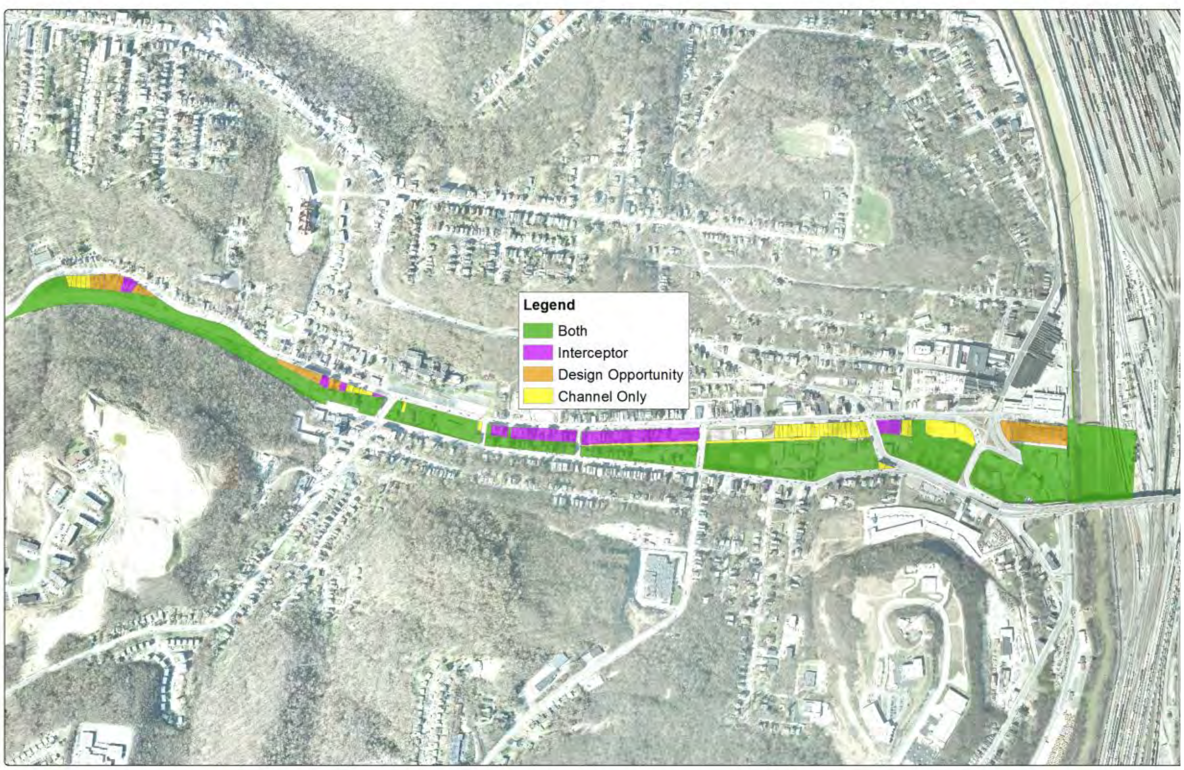


Figure 1.02-7 Overview of Updates to Preliminary Property Acquisition Plan

d. Utility Review

The December 2009 *Utility Review s*ummarized existing utilities in the vicinity of the proposed sewer separation areas including type, size, pipe material, age/installation date, and location in each of the sewer separation areas. Utility information for this report was primarily obtained through the Cincinnati Area Geographical Information System (CAGIS) and Ohio Utility Protection Services (OUPS), but record information was also obtained from the following utility departments: Cincinnati Bell, MSDGC, Division of Stormwater Management Utility (SMU), City of Cincinnati Transportation and Engineering (CDOTE), Greater Cincinnati Water Works (GCWW), Duke Energy, Time Warner Cable, and Level 3 Communications.

As design progress, additional utility review is being conducted and incorporated as appropriate into the advanced design.

e. Topographic Review

The December 2009 *Topographic Review* included a preliminary assessment of various topographic features that could impact the implementation of the proposed improvements included in the PEA. Topographic information for this report was primarily obtained through the CAGIS and was utilized to set existing conditions for the hydrologic modeling that was summarized in the PEA. Features assessed in this review included terrain, soils, slopes, and vegetative cover. The report concluded the topographic and surficial characteristics of the proposed sewer separation project areas provide good conditions for sewer installations, as further discussed in Section 2.02.D.

f. Geotechnical Review

The January 2010 *Geotechnical Review* summarized existing geotechnical conditions in the various sewer separation areas. The information contained in this report was intended to provide an initial screening of potential soils and groundwater issues and to provide guidance in conducting the more detailed geotechnical investigations required for further design efforts. The report indicated bedrock should be anticipated during the installation of the proposed storm sewers at a number of locations and the suitability for infiltration of the soils in the proposed project areas was generally poor.

Existing geotechnical information was acquired though available spatial data from the Natural Resources Conservation Service (NRCS) and previous soil boring data. For the purposes of this review, the soil type, hydrologic soil group classification, and the suitability for infiltration rating were summarized for each of the proposed sewer separation areas.

As design progresses, additional geotechnical review is being conducted and incorporated into advanced design.

g. Intersection Traffic Movement Assessment Report

The December 2009 *Intersection Traffic Movement Assessment Report* (ITMAR) included an analysis of traffic movements at ten strategic intersections throughout the urban valley conveyance system corridor using actual intersection traffic counts and projected future traffic volumes. The report also provided a general operations-based assessment of six alternative transportation improvements that could be considered for implementation in conjunction with the Wet Weather Strategy.

The traffic counts indicated large peak-hour volumes ranging from 600 vehicles per hour (vph) to nearly 4,000 vph in the PM peak at Queen City Avenue and Harrison Avenue. Nearly 5,000 vph were counted during the PM peak hour at Harrison Avenue and the Western Hills Viaduct. The preliminary modeling results suggested the existing conditions provide the best level of service (LOS), however, the remaining alternatives provide a reasonably similar LOS.

h. Alternatives Development and Refinement Report

The April 2010 *Alternatives Development and Refinement Report* provides additional traffic modeling refinement to the ITMAR and included a general assessment of nonoperation's-based performance criteria for the alternative transportation improvements included in the ITMAR, along with recommendations and projected budgetary costs for the selected transportation alternative(s) that could be implemented in conjunction with the Wet Weather Strategy.

The refined traffic models confirmed the existing conditions and alternative transportation improvements provide similar results with respect to LOS, delay, and queuing at the key intersections analyzed. Because of the potential non-operations benefit of the alternative transportation improvements considered for implementation in conjunction with the Wet Weather Strategy, an alternatives decision matrix was developed to evaluate each alternative on its resulting impact to eight additional criteria: water quality enhancement, channel cost, transportation construction cost, open space connectivity, mass transit accommodation, property acquisition requirements, revitalization potential, and viaduct improvement capability. The matrix used an unweighted five-point scoring system, and of the six alternative transportation improvements considered, the no build/change scored the lowest while the two-way Westwood Avenue and Queen City Avenue alternative scored the highest. This would indicated modifying Westwood Avenue into a two-way boulevard and Queen City Avenue into a two-way main street would result in the largest benefit, as it pertains to the eight nonoperational considerations mentioned previously.

i. Geotechnical Exploration Report

The April 2010 *Preliminary (Stage 1A) Geotechnical Exploration* presented the results of the engineering reconnaissance, test borings, testing, engineering analyses, and recommendations for the implementation of the Wet Weather Strategy as identified in the PEA, with a summary of associated soils and groundwater observations. This report was commissioned to supplement information gathered in completing the Geotechnical Review noted above. It includes a compilation of new test borings and historical borings that were performed within the project area.

A total of 71 new test borings were drilled throughout the study area with a review of 96 pertinent historical test borings. New borings focused on the central corridor area between Queen City and Westwood as well as along proposed alignments in the strategic sewer separation areas. The results of this effort concluded:

(1) Bedrock is located at varying depths throughout the watershed and will likely be encountered during the proposed storm sewer installations.

(2) Groundwater elevations are generally deeper than the proposed storm sewer installations, but groundwater may be encountered in isolated locations.

j. USEPA Phase 1 Area-wide Environmental Site Assessment Report

The March 2010 *USEPA Phase 1 Area-wide Environmental Site Assessment* was performed in the area of the urban valley conveyance system. The parcels evaluated between Queen City and Westwood Avenue were characterized given the historical use and potential environmental concerns and this information was used to supplement the planning and diligent efforts of the project development and the property acquisition planning.

k. Community Opportunities Plan

The April 2010 *Community Opportunities Plan* (COP) incorporated MSDGC's *Communities of the Future* initiative into the Wet Weather Strategy. The COP established a preliminary foundation for comprehensive revitalization opportunities and identifies potential community assets. Elements from this plan were used to shape enhancements to the urban valley conveyance system that were included in the PEA. Figure 1.02-8 is a graphical representation of the COP representing the hybrid VCS.

Figure 1.02-8 COP representation of the VCS

I. Lick Run Basis of Design

The April 2010 *Lick Run Wet Weather Strategy Basis of Design* (BOD) provides a review of the existing physical conditions and regulatory constraints that might affect the implementation of the Wet Weather Strategy developed in the Conceptual Report and refined in the PEA. Significant items included in the BOD are as follows:

(1) Introduction of a subsurface stormwater conveyance box conduit which, in conjunction with the open channel, form the current proposed hybrid valley conveyance configuration as shown in Figure 1.02-9.

(2) Meandering low-flow channel alignment.

(3) Inclusion of best management practices (BMPs) features including the headworks forebay, structural separators, aeration/recirculation facilities, and an online pond.

(4) Community amenities including bike/pedestrian facilities, shelters, public open space areas, and community recreation areas.

(5) Retaining structures at strategic locations to maximize revitalization pads.

(6) Hydraulic connections between the subsurface stormwater conveyance box conduit and low flow channel.

(7) Enhanced landscaping.

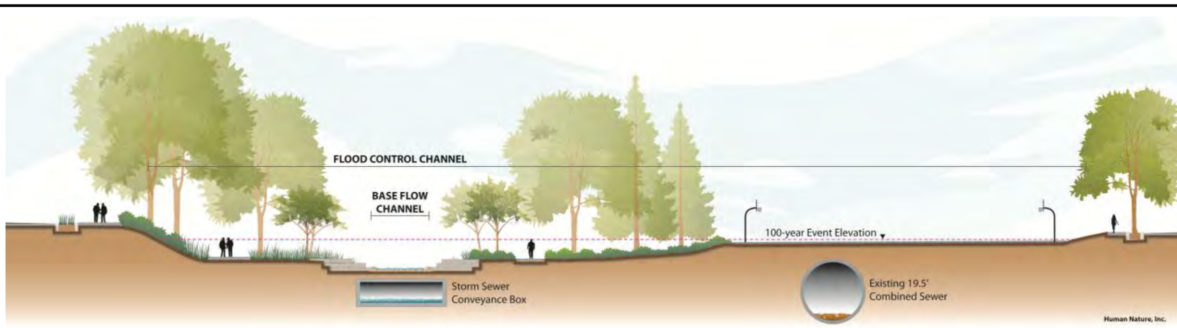


Figure 1.02-9 Typical Combination Box Conduit and Open Channel Cross Section

The report also included preliminary plans and cost opinions in response to the aforementioned conditions and constraints, including enhancements proposed for the urban valley conveyance system.

m. Life Cycle Cost Analysis

In October 2010, a life cycle cost analysis was performed to develop a baseline for comparison to other potential CSO control projects that may be implemented to meet the requirements of the Consent Decree. The life cycle cost analysis accounted for construction costs, operations costs, and maintenance costs. This analysis indicated the present value of the 100-year maintenance and replacement costs for the Wet Weather Strategy was approximately $20 million. Additional discussion on costs is presented in Section 4.

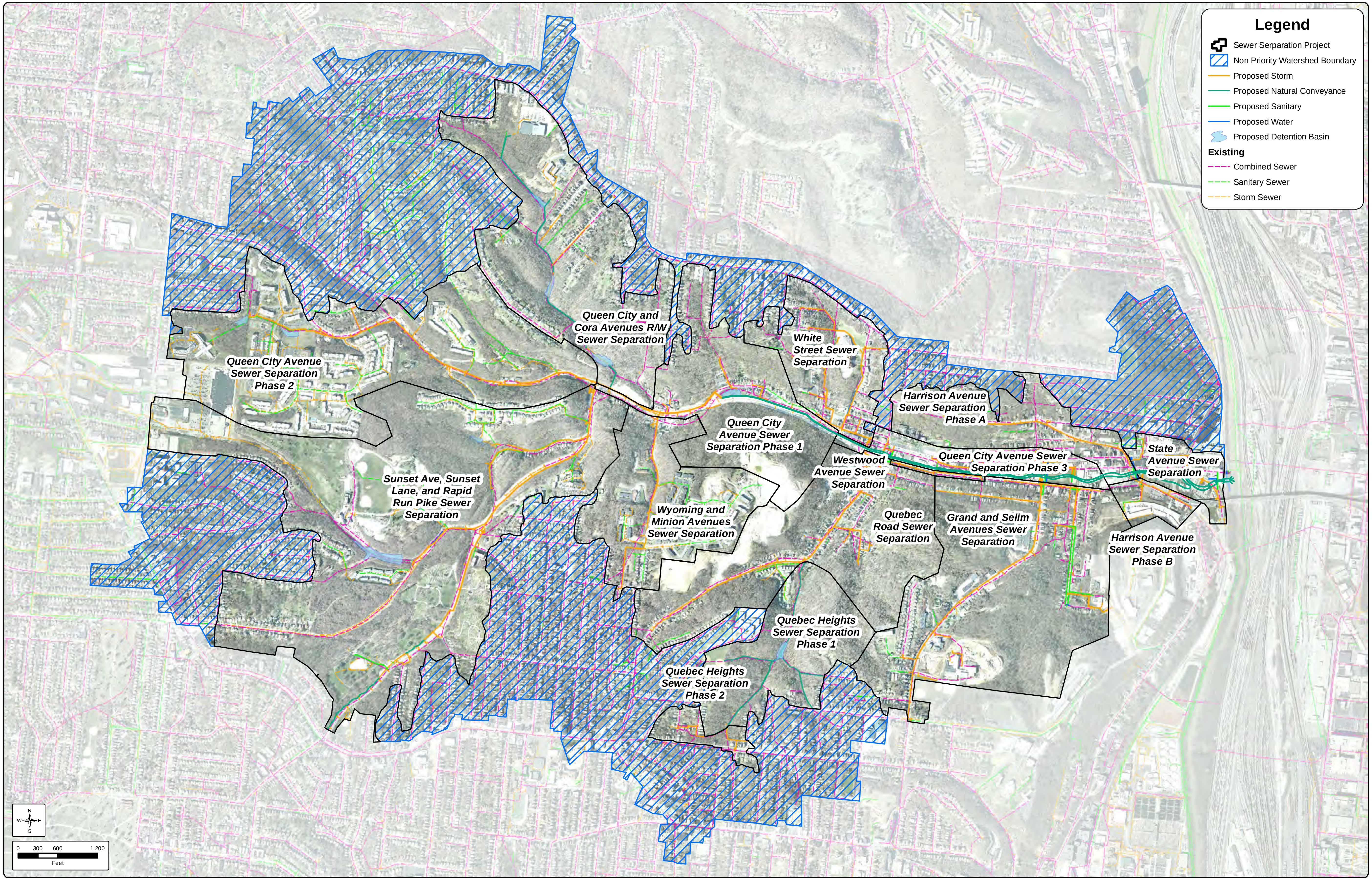
n. 30 Percent Design Submittals for Sewer Separation Areas

Thirty percent design drawings, modeling, and opinion of probable construction cost for the sewer separation projects were prepared and submitted in the summer and fall of 2010. Development of these documents included updated hydrologic and hydraulic modeling to that originating from the PEA, topographic field surveys, additional soils investigations, and utility coordination. The focus of this effort was to develop refined construction cost opinions based on a higher level of design to aid MSDGC in its Wet Weather Strategy decision-making process.

It should be noted that the proposed sewer separation projects were modified in size, location, and name as the overall Wet Weather Strategy continued to be developed. The original project areas defined in the PEA were based on topography and identified by drainage basins. As the projects moved into 30 percent design, areas were redefined as sewer separation construction projects. The project names were later changed and assigned project identification numbers according to standard MSDGC procedure. Table 1.02-1 details these changes. Figure 1.02-10 shows each sewer separation project by the MSDGC naming convention. The current status of the sewer separation projects is discussed further in Section 2.

Appendix F contains the current 30 percent design drawings for the sewer separation project, and Appendix D contains the hydrologic and hydraulic modeling results.

DRAFT 03/30/12



SEWER SEPARATION PROJECT NAMES
LICK RUN WET WEATHER STRATEGY

METROPOLITAN SEWER DISTRICT OF GREATER CINCINNATI

STRAND ASSOCIATES

FIGURE 1.02-10
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PEA Name	30 Percent Design Name	MSDGC Updated Name	Project ID
Basin A–Plastics Modeling Company	Plastics Modeling SSA	Grand and Selim Avenues Sewer Separation	11240210
Basin B–Old St. Francis St. George Hospital	Harrison Ave SSA	Harrison Avenue Sewer Separation	11240050
	Central Queen City Ave SSA	Queen City Avenue Sewer Separation Phase 1	11240270
	State Ave SSA	State Avenue Sewer Separation	11240070
	Central Westwood Ave SSA	Westwood Avenue Sewer Separation	11240250
Basin C–Elder Baseball Fields	Quebec Rd Separation Area	Quebec Road Sewer Separation	11240110
	Quebec Heights Separation Area (including Glenway Woods and Wells Street)	Quebec Heights Sewer Separation Phase 1 Quebec Heights Sewer Separation Phase 2	11240170 11240190
Basin D–Central Fairmount Elementary	White St SSA	White Street Area Sewer Separation	11240090
Basin E–Lick Run Way; Basin G–Murray's Pub	Queen City Ave SSA	Queen City Avenue Sewer Separation Phase 3	11240230
Basin F–Autumn Wood	Wyoming Ave Separation Area	Wyoming and Minion Avenues Sewer Separation	11240030
Basin H–Kroger/Jusdon Home Care	Fenton Ave Separation Area	Queen City and Cora Avenues R/W Sewer Separation	11240150
Basin J–Queenswood; Basin K–Kroger/Aspen Apartments	Western Queen City Ave Separation Area	Queen City Avenue Sewer Separation Phase 2	11240130
Basin L–Woodcrest Park; Basin M–Walmart/Dunham Recreation	Sunset Ave SSA	Sunset, Rapid Run Area Sewer Separation	11240010

Table 1.02-1 Sewer Separation Area Project ID

o. Temporary Connections Modeling Memorandum

The April 2011 *Lick Run Green–Temporary Connections Modeling* memorandum summarized updates to the Lick Run model, to account for the temporary connections of the proposed storm sewers to the existing CSS, required because of the sequence of Wet Weather Strategy construction. The memo indicated the modeling effort shows the hydraulic grade line (HGL) for each future temporary conditions scenario is comparable and remains either similar to, or lower, than the base conditions HGL throughout each of the construction phases along the Lick Run trunk sewer. Essentially, the temporary connections would not exacerbate existing conditions and may slightly improve upon existing conditions at certain locations.

p. Ultimate Conditions Model Update Memorandum

The June 2011 *Lick Run Green–Ultimate Conditions Model Update* memorandum summarized the most recent modeling updates made for the Ultimate Conditions scenario of the Lick Run Wet Weather Strategy. This modeling effort update shows that the total wet weather inflow volume is simulated to be reduced by 1,036 MG for the 1970 Typical Year, and that the combination of the separation projects and the RTC facility contribute to the reduction of the modeled overflow volume by about 822 MG. As a result, the percent control for the 1970 Typical Year increases from 40 percent to 85 percent.

q. Stormwater Quality Modeling Report

The October 2011 *Lick Run Watershed Phase 2 Stormwater Modeling and Assessment Report* was completed to provide a preliminary recommendation on proposed stormwater control measures to be included in the Wet Weather Strategy. Twenty-eight detention basins and twenty-three proposed structural separators were evaluated based primarily on water quality benefit. The memo recommended nine detention basins and five structural separators at major inlets of stormwater to the urban valley conveyance system for further consideration and inclusion as a part of the Wet Weather Strategy. The nine detention basins and five structural separators were estimated to have construction costs ranging between $1.41 to $1.96 million and $1.27 to $2.95 million, respectively, which have already been included in the overall project costs. The ranges allow for a variety of design approaches to be included in the final Wet Weather Strategy design.

r. Value Engineering Study

The *Lick Run Wet Weather Strategy Value Engineering Study Report*, submitted in January 2011, was conducted by a team of multidisciplinary specialists in CSO control and "green solutions" for stormwater control. The study included two sets of meetings at the MSDGC Wastewater Engineering and Education Center building at the Mill Creek WWTP, from November 29 to December 2 and December 14 to 15, 2010. Using the aforementioned project documents, the VE team assessed the viability and feasibility of the Wet Weather Strategy and determined the approach being proposed by the project team was technically feasible and would have a high probability of meeting the requirements of the Consent Decree. The VE team also identified potential opportunities to enhance the value of the proposed Wet Weather Strategy in terms of its functionality and cost. The opportunities were categorized by theme and/or element including Reduce Untreated Overflow Volume, Open Channel, Pipe Cost, Sewer Installation Type (Storm, Sanitary, or Combined), Detention, Operations and Hydraulics, and Constructability.

Results of the VE study indicated the expected stormwater capture volume and resulting CSO reduction of the Wet Weather Strategy to be conservative and an appropriate milestone in complying with MSDGC's WWIP. The final report states:

> "The approach being taken to control wet weather combined sewer overflows in the Lick Run catchment area by separating sanitary flows from storm water flows and reducing the amount of storm water entering the sewer system through

detention and infiltration appears to be sufficient to achieve the goal of reducing combined sewer overflows by 2 BG per year and meet the Consent Decree."

s. Value Engineering Study Recommendation Evaluation Summary Memo

In the fall 2011, MSDGC initiated three alternate solution evaluations for the Wet Weather Strategy, particularly with regard to the sewer separation strategy, in response to recommendations made by the VE team and other stakeholders. The alternate solutions evaluated included:

(1) Utilizing the existing combined sewer system for stormwater conveyance and installing a new sanitary sewer system throughout the watershed.

(2) Sizing the proposed storm sewer system to convey flows from non-priority and priority areas to allow for future full separation.

(3) Sizing the proposed storm sewer system and valley conveyance system to convey flows from the typical annual event from the priority areas only.

The coarse alternative solution evaluations included assumptions used to develop costs. The results of the evaluations showed each of the alternative solutions had a higher construction cost opinion when compared to the strategic sewer separation approach. The coarse construction cost opinions for the alternative solutions are $144.2 million, $123.8 million, and $45.0 million, respectively.

t. Strategic Sewer Separation Technical Memo

The July 2011 *Strategic Sewer Separation Technical Memo* was developed to explain and document the reasoning behind the strategic sewer separation approach. The memo explained the priority and non-priority areas and the decision to size the proposed storm sewers to convey stormwater runoff from the priority areas only, which centered largely around the prohibitive costs associated with "full separation." Several implementation issues were identified, but the memo confirmed the viability of the strategic sewer separation approach based on the following four factors:

(1) Cost-Effectiveness

(2) Level of Control

(3) Level of Service

(4) CSO Compliance

u. History/Architecture Study

In December 2011, a Phase I History/Architecture Report was submitted to address proposed alterations within the defined Area of Potential Effects (APE) for the valley conveyance corridor. The federal grant for this project is provided by the United States Department of Housing and Urban Development, United States Department of Transportation, and the United States Environmental Protection Agency (HUD-DOT-EPA) as part of the jointly funded Community Challenge/Tiger II Grant Program, Fiscal Year 2010.

Archival research and history/architecture fieldwork were conducted from May through July 2011. The literature review for this project entailed an examination of the Ohio Historic Preservation Office's Online Mapping System and a review of the South Fairmount files at the Cincinnati Preservation Association's office. Historic map research was conducted at the Public Library of Cincinnati and Hamilton County in Cincinnati, Ohio. Construction dates were established using a combination of the Hamilton County Auditor's Office online records, historic map and atlas research, deeds, and field observations.

The APE is characterized largely by pre- and post-1968 residential, commercial, and industrial buildings. Many of the pre-1968 residential buildings have undergone numerous alterations, including replacement of sash, application of aluminum and vinyl sidings, and building additions. Fieldwork identified 193 previously unrecorded resources within the APE. No National Register of Historic Places (NRHP) eligible historic district was identified in the APE and the immediate project area. The literature review revealed one property previously listed in the NRHP and 20 resources previously documented in the Ohio Historic Inventory within the APE. In addition to the NRHP-listed St. Francis Hospital, 30 other resources within the APE are recommended as eligible for inclusion in the National Register of Historic Places (Table 1).

2. Related Efforts

In addition to the aforementioned reports, which presented technical information regarding the feasibility, benefits, and costs associated with the Wet Weather Strategy, various entities have studied the project from a community revitalization standpoint. In particular, the Hamilton County Regional Planning Commission (HCRPC), the City of Cincinnati, MSDGC, and other groups have been involved in visioning and planning urban revitalization elements associated with this project. In March 2010, MSDGC established the Communities of the Future Advisory Committee (CFAC) to provide guidance and advice on executing the *Communities of the Future* initiative. Efforts relating to the Wet Weather Strategy include the following:

a. South Fairmount–CSO 5 Urban Audit

The September 2009 *South Fairmount–CSO #5 Urban Audit,* conducted by the HCRPC, presented an evaluation of the buildings located within the Lick Run valley conveyance system corridor. This included identification of historically significant properties as well as an analysis of existing structure conditions.

The report identified 24 buildings of historical or architectural significance and found that most buildings appeared to be in good condition or require only minor repairs, though nearly 20 percent of the buildings require major repairs or appeared to be in critical condition.

b. Lick Run Daylighting and Urban Revitalization Plan–Demographic and Policy Framework

In July 2009, the *Lick Run Daylighting and Urban Revitalization Plan–Demographic and Policy Framework* was completed. Efforts included a current demographic perspective for the South Fairmount neighborhood covering population, income, household structure, housing vacancy, educational attainment, and employment concentrations, with information for 2000 as well as forecasts for 2008 and 2013. It also included a discussion of broader policy consideration for why the proposed revitalization strategy is logical to consider, with insight into regional and national trends that, over the midterm, will increase demand for urban infill sites. The discussion also highlighted practical real estate benefits generated by proximity to parks, greenways, and trail systems.

The report noted the population of South Fairmount is declining, and the median household income is below the City of Cincinnati average while the household size is larger than the City of Cincinnati average.

c. Lick Run Watershed Strategic Implementation Plan

In July 2011, the USEPA published the *Lick Run Watershed Strategic Implementation Plan* final report. The report lists Framework Actions and Supporting Actions needed to organize and efficiently complete efforts across multiple agencies, departments, and organizations. The Framework Actions include Community Engagement and Vision Definition; Park and Open Space Coordination; Code and Regulatory Framework; Land Acquisition, Brownfields, and Land Use Strategy; and Maintenance Agreements. The Supporting Actions include Planning and Historic Preservation; Housing and Community Development; Transportation, Transit, and Bikeways; and Economic Development.

The final section of the report provides guidance for implementation of the recommendations in the strategic integration plan.

1.03 DEFINITIONS

APE	Area of Potential Effects
BCE	*Business Case Evaluation for CSO 005 Lick Run Wet Weather Strategy*
BOD	*Lick Run Wet Weather Strategy Basis of Design*
BMP	best management practices
BUSTR	Ohio Department of Commerce Bureau of Underground Storage Tanks
CAGIS	Cincinnati Area Geographical Information System
CDOTE	Cincinnati Department of Transportation and Engineering
CFAC	Communities of the Future Advisory Committee
Conceptual Report	*Lick Run Conceptual Report*
COP	*Community Opportunities Plan*
CSO	Combined Sewer Overflow
CSS	Combined Sewer System
DI	Ductile Iron
EHRT	Enhanced High Rate Treatment
ESA	Environmental Site Assessment
EXTRAN	Extended Transport Module
ESP	Early Success Projects
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FIS	Flood Insurance Study
fps	feet per second
GCWW	Greater Cincinnati Water Works
GIS	geographical information system
HCRPC	Hamilton County Regional Planning Commission
HGL	hydraulic grade line
HSG	Hydrologic Soil Group
ITMAR	Intersection Traffic Movement Assessment Report
LOS	Level of Service
LMCPRP	Lower Mill Creek Partial Remedy Plan
LTCP	long-term control plan
MOT	maintenance of traffic
MOU	Memorandum of Understanding
MS4	municipal separate storm sewer system
MSDGC	Metropolitan Sewer District of Greater Cincinnati
NGVD	National Geodetic Vertical Datum
NHRP	National Register of Historic Places
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resource Conservation Service
NRHP	National Register of Historic Places
ODNR	Ohio Department of Natural Resources
ODOT	Ohio Department of Transportation
OEPA	Ohio Environmental Protection Agency

OHPO	Ohio Historical Preservation Office
OPCC	opinion of probable construction cost
ORSANCO	Ohio River Valley Sanitation Commission
OUPS	Ohio Utilities Protection Service
PEA	Preliminary Engineering Analysis Report- Hydrology and Hydraulics
PTI	Permit to Install
RRP	Renovation, Repair, and Painting
SFHA	Special Flood Hazard Area
SHPO	State Historic Preservation Officer
SMU	Division of Stormwater Management Utility
StormCAD	StormCAD V8 XM Edition
Strand	Strand Associates, Inc.®
SWEP	Sustainable Watershed Evaluation Process
SWM	Systemwide Model
SWMM	Stormwater Management Model
VCS	valley conveyance system
USACE	United States Army Corps of Engineers
USDOJ	United States Department of Justice
USEPA	United States Environmental Protection Agency
VCS	valley conveyance system
VE	Value Engineering
VE Study	*Value Engineering Study*
WinSLAMM	WinSLAMM V.9.4
WQC	Water Quality Certification
WWIP	Wet Weather Improvement Program
WWS	Lick Run Wet Weather Strategy
WWTP	wastewater treatment plant

SECTION 2
STRATEGIC SEWER SEPARATION

2.01 INTRODUCTION

As indicated previously in Section 1, the foundation of the Wet Weather Strategy consists of two primary elements, strategic sewer separation and an urban valley conveyance system (VCS). The strategic sewer separation element is comprised of 14 projects totaling approximately 70,000 linear feet of new stormwater conveyance, in both closed conduit and open channel designs. The new storm sewers and open channel systems will ultimately convey captured stormwater to the Mill Creek via the urban VCS.

This section will discuss the strategic sewer separation aspect of the Wet Weather Strategy, including background, modeling, design criteria, design elements, benefits, schedule, and potential challenges. Costs are discussed separately in Section 4.

2.02 BACKGROUND

A. Purpose

MSDGC submitted its Wet Weather Improvement Plan (WWIP) on June 4, 2009, representing an estimated $3.29 billion investment (in 2006 dollars). The financial implications of implementing the WWIP to comply with the terms of the consent decree have been an important consideration as MSDGC evaluates alternative CSO reduction opportunities, through *Project Groundwork*.

In a letter dated June 5, 2009, Ms. Sally Swanson, Chief of the Water Enforcement and Compliance Assurance Branch, USEPA Region 5, stated to the Hamilton County Board of County Commissioners, the City of Cincinnati, and MSDGC:

> "…the Residential Indicator calculated in accordance with the Financial Capability Guidance for a $3.29 billion (in 2006 dollars) WWIP would reach an unprecedented high level of 2.8%..."

Because of the high financial burden associated with this program, MSDGC has negotiated a phased implementation approach with the USEPA. A major focus of Phase 1 is the reduction of approximately two billion gallons annually from CSOs discharging to the Mill Creek by the end of 2018. Because CSO 005, in the Lick Run Watershed, discharges the greatest CSO volume in the Lower Mill Creek Watershed on an annual basis, a desired goal of reducing CSOs by 800 million gallons annually was established for the Lick Run Watershed to help achieve the two-billion-gallon reduction.

B. Watershed Characteristics

The Lick Run Watershed has several unique characteristics, with respect to both the natural and built environments, that make strategic sewer separation a viable and cost-effective option. Some of the defining and most important of these characteristics are listed below. Larger versions of the figures in this section can be found in Appendix B.

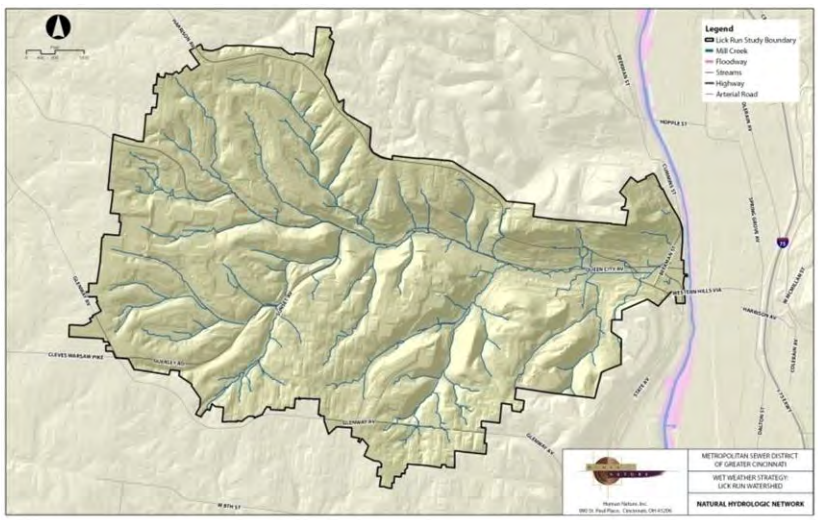
Figure 2.02-1 presents the Lick Run Watershed modern day landscape, illustrating the natural drainage systems that once served this watershed (blue lines) which are now piped through the CSS (red lines). The figure also illustrates the dense residential development on the outer reaches of the watershed and the undeveloped hillsides draining to the central corridor between Queen City Avenue and Westwood Avenue.

Source: Human Nature, Inc.

Figure 2.02-1 Combined Sewer System and Development in the Lick Run Basin

1. Hydrology

The pre-development hydrologic network, Figure 2.02-2, shows an extensive system of creeks and streams within the watershed. At one point, the hydrologic network included almost 31 miles of streams. Under pre-development conditions, this network naturally conveyed stormwater runoff to the historic Lick Run stream located in the central corridor and, eventually, to Mill Creek. Today, most of these natural systems have been replaced by combined sewers leaving approximately 4 miles of stream system still remaining within the watershed. Currently, both the combined sewers and the remnants of the natural systems all drain to the 19.5-foot-diameter sewer located between Queen City Avenue and Westwood Avenue.

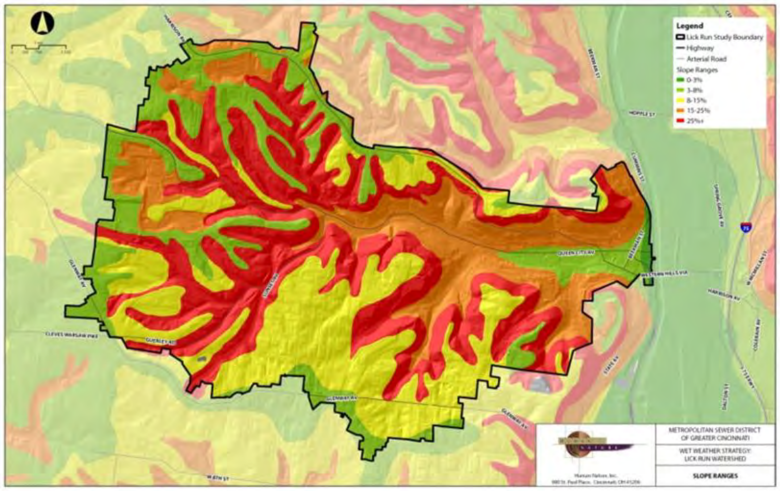


Source: Human Nature, Inc.

Figure 2.02-2 Pre-development Hydrologic Network in the Lick Run Watershed

2. Topography

The Lick Run Watershed is characterized by steep, wooded hillsides as well as residential development throughout the upper reaches of the watershed. Such characteristics strongly influenced the Wet Weather Strategy, which proposed sewer separation in strategic locations, including regions where stormwater runoff from undeveloped hillsides enters the CSS and developed areas already served by separate sanitary and storm sewers that eventually connect to the CSS. The topography also influences hydrologic patterns, vegetation, and habitat, and can even constrain land uses. As shown in Figure 2.02-3, the project area was classified by steepness of terrain (i.e. slope range), allowing for a quick assessment of areas where stormwater can collect (i.e., low lying areas) versus areas where stormwater will flow rapidly (i.e., steep areas). Slopes were classified into five ranges: 0 to 3 percent, 3 to 8 percent, 8 to 15 percent, 15 to 25 percent, and over 25 percent.



Source: Human Nature, Inc.

Figure 2.02-3 Slope Ranges in the Lick Run Watershed

Steep hillsides, defined as areas with slopes of 15 percent or greater, can exacerbate the flow rate and volume of stormwater runoff entering sewer infrastructure. The Lick Run Watershed has 1,345 acres of steep hillsides, representing almost 50 percent of the total project area.

The topographic and surficial characteristics of the watershed provide good conditions for storm sewer installations. Sloped landscapes allow for the sewers to easily transport stormwater runoff from the hillsides to the central corridor. However, steep slopes can cause significant design challenges relating to unstable hillsides, landslides, and high stormwater velocities.

Additionally, there are several stormwater detention basins that currently exist throughout the watershed as well as existing natural depressions that could provide additional opportunities for stormwater detention. The *Topographic Review* report presents more detailed information regarding the topography and surficial characteristics of the watershed.

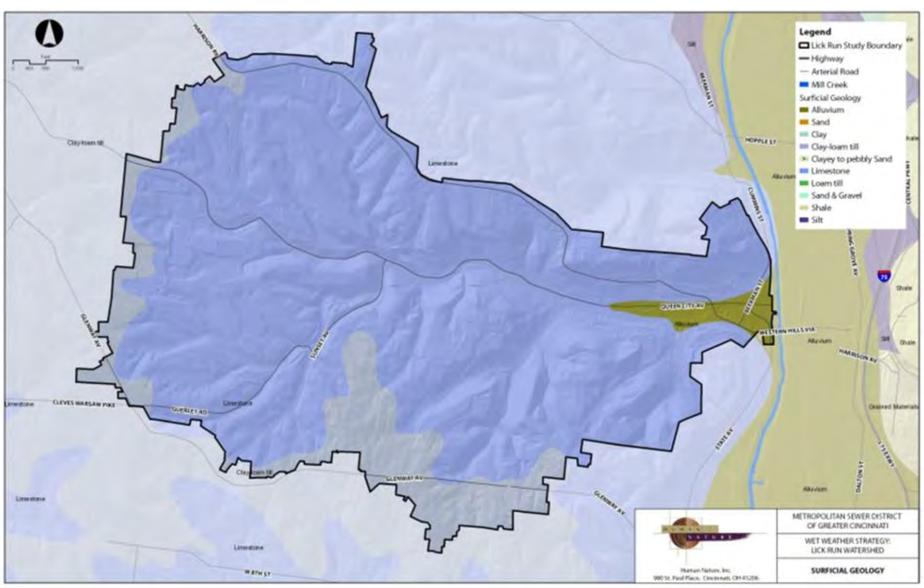
3. Characterization of Existing Soils

Information from the NRCS including the soil type, HSG classification, and the suitability for infiltration rating, along with information from soil boring logs, was reviewed and summarized in the *Geotechnical Review* report. Table 2.02-1 presents a summary of this information by project area defined further in Section 2.02.D.

1	Total Acreage	Percentage of Area HSG B	Percentage of Area HSG C
Plastics Modeling Company	124	11.0	82.0
Elder Baseball Fields	193	11.5	88.5
Autumn Woods	85	59	41
Woodcrest Park	110	4	96
Walmart-Dunham Recreation	217	26	74
Kroger-Aspen Apartments	182	17	83
Queenswood Subdivision	60	1	99
Kroger-Judson Home Care	100	5	95
Murray's Pub	77	2	98
Lick Run Way	93	4	96
Old St. Francis St. George Hospital	118	40	60
Central Fairmount Elementary	10	15	85

Table 2.02-1 Hydrologic Soil Group by Drainage Area

Additionally, the nature of subsurface rock (i.e., geology) helps to determine not just the nature and chemistry of the soil above but also the rate at which it forms. Geologic formations of alluvium, sand, and gravel provide the greatest opportunities for natural infiltration as they can allow for the greatest subsurface transmission and conveyance of water. However, as shown in Figure 2.02-5, geology in the Lick Run Watershed is primarily limestone and clay-loam till, with small deposits of alluvium near the confluence with Mill Creek.

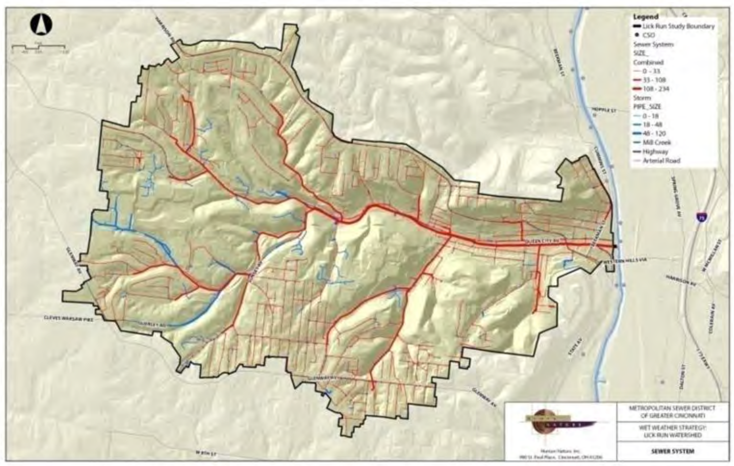


Source: Human Nature, Inc.

Figure 2.02-5 Surficial Geology in the Lick Run Watershed

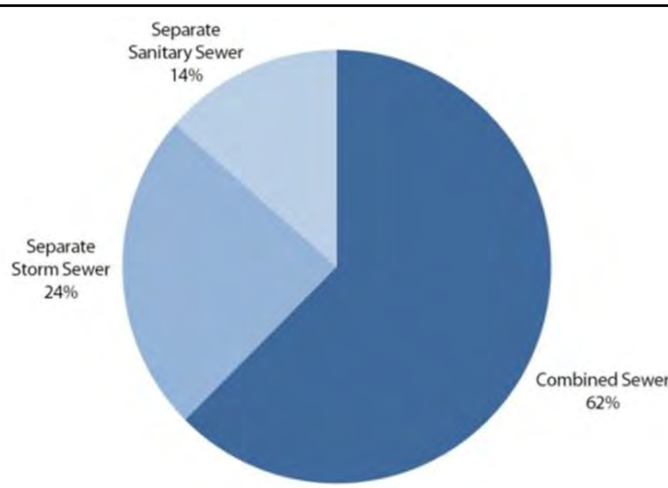
4. Utility Infrastructure

There are currently 88 miles of combined sewers, sanitary sewers, and separate storm sewers in the watershed. As shown in Figure 2.02-6, sewer infrastructure in the Lick Run Watershed generally follows the pre-development hydrologic network. Figure 2.02-7 shows the distribution of the underground sewer network by type (i.e., combined, separate sanitary, or separate storm sewer). The sewer network captures and conveys all the runoff from the watershed.



Source: Human Nature, Inc.

Figure 2.02-6 Sewer Infrastructure in the Lick Run Watershed

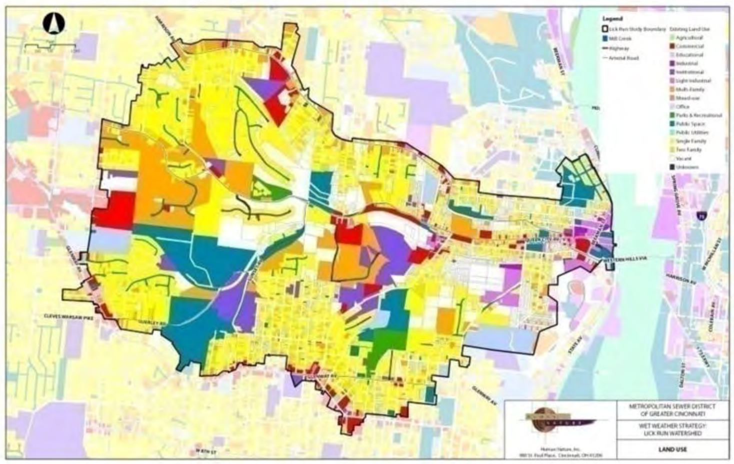


Source: Human Nature, Inc.

Figure 2.02-7 Distribution of Underground Sewer Infrastructure by Type

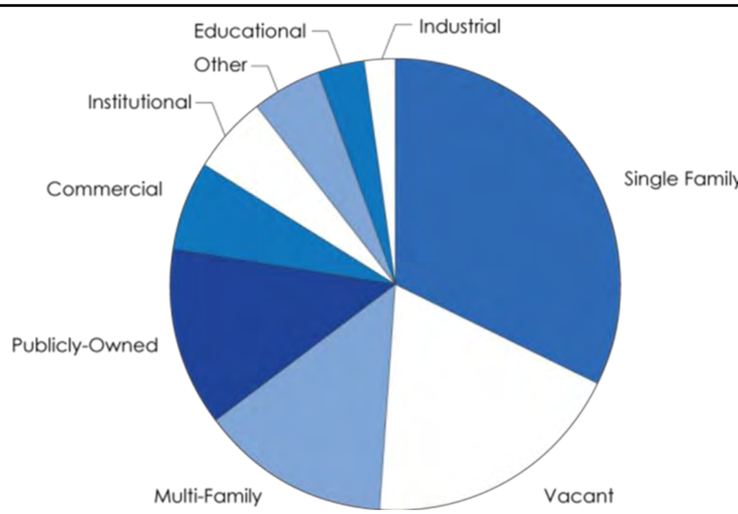
5. Land Use and Opportunity Properties

Land use is the documentation of human uses of the landscape. Land use within the Lick Run Watershed is primarily residential (both single-family and multifamily); however, vacant and commercial properties also comprise a significant portion of the watershed. Figure 2.02-8 shows distribution of land use within the watershed, and Figure 2.02-9 summarizes the distribution of land use by area.



Source: Human Nature, Inc.

Figure 2.02-8 Existing Land Use in the Lick Run Watershed



Source: Human Nature, Inc.

Figure 2.02-9 Distribution of Existing Land Use by Area

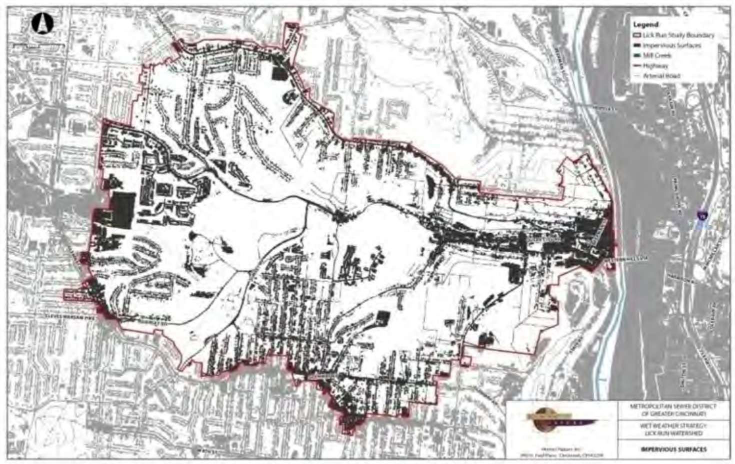
Data for land uses was sorted based on type (e.g., institutional or vacant properties) and owner (e.g., public or private). This provided a list of “opportunity properties,” or land uses that may be utilized for infrastructure partnerships and collaboration. Opportunity properties include schools, parks, open spaces, institutional properties, road right-of-way, and vacant or abandoned properties. As potential areas for public-private partnerships, these land uses can integrate multiple stakeholders, thereby increasing public involvement and improving public perception of infrastructure projects. Figure 2.02-10 shows distribution of opportunity properties within the watershed.

Source: Human Nature, Inc.

Figure 2.02-10 Opportunity Properties in the Lick Run Watershed

6. Impervious Surfaces

Impervious surfaces include buildings, roadways, parking lots, sidewalks, and bridges. These areas can greatly increase the rate and volume of stormwater runoff by reducing or even preventing the natural infiltration of stormwater into soils. As shown in Figure 2.02-11, impervious surfaces cover approximately 827 acres, or 30 percent of the total watershed. Roadway and building impervious surfaces throughout the watershed account for approximately 16 percent of the total watershed area. Also, as alluded to earlier, much of the impervious area throughout the watershed is concentrated along the outer reaches, which are comprised of primarily residential development, and along the central corridor, which is comprised of primarily roadway surfaces and a mix of commercial and residential development. The concentrated locations of the impervious surface in the watershed served as one of the reasons for the strategic sewer separation strategy described further in Section 2.02.C.



Source: Human Nature, Inc.

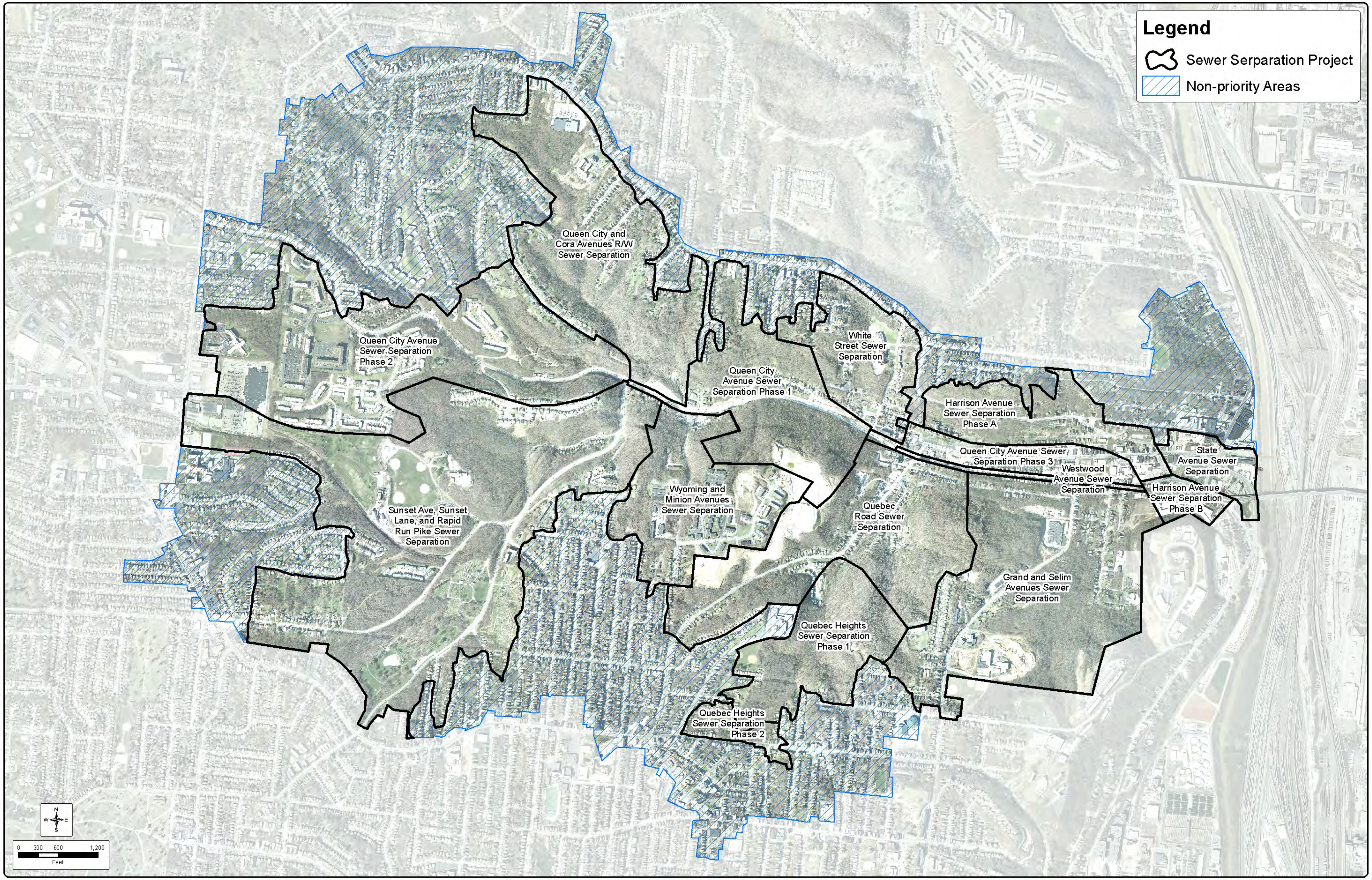
Figure 2.02-11 Impervious Surfaces in the Lick Run Watershed

C. <u>Strategic Sewer Separation Approach</u>

An understanding of the financial constraints and watershed characteristics described above led to the development of the strategic sewer separation approach. The limits of the proposed sewer separation within the watershed were determined with the goal of capturing as much stormwater as possible with focused investments in new infrastructure. With that goal in mind, the sewer separation approach targeted stream entry points, large undeveloped hillsides, and areas already served by separate storm and sanitary systems that eventually discharge into the CSS. These targeted areas of the watershed are identified as “priority areas” and represent approximately 1,800 acres.

Highly developed areas on the upper reaches of the watershed requiring extensive separation, and therefore expense, were excluded from the priority areas unless it was reasonably efficient to extend new separated storm sewers to connect with existing drainage systems. These upland areas are termed “non-priority areas” and represent approximately 900 acres. Wet weather strategies to be implemented in the upland non-priority areas include best management practices such as reforestation, detention, small-scale site-specific controls, and downspout disconnection. The small-scale site specific controls, identified as early success projects, are further discussed in Section 2.05.C. A number of these projects have either been constructed or are in the process of being constructed. Figure 2.02-12 presents the priority and non-priority boundaries as well as the current sewer separation project drainage areas.

Strategic sewer separation is proposed primarily through the installation of new storm sewers or natural conveyance systems sized to convey stormwater from the priority areas only. In some isolated cases, it was deemed more cost-effective to install new sanitary sewers and utilize the existing combined sewer infrastructure for stormwater conveyance. It is assumed that building connections to the combined sewer (including downspouts) will remain connected to the combined sewer within the priority areas, although capacity has been provided in the proposed storm sewers should these disconnections occur



NON-PRIORITY AND SEWER SEPARATION PROJECT AREAS
LICK RUN WET WEATHER STRATEGY

METROPOLITAN SEWER DISTRICT OF GREATER CINCINNATI

STRAND ASSOCIATES, INC.® ENGINEERS

FIGURE 2.02-12
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Path: \\strand.com\Projects\MAD\3500--3599\3560\002\Data\GIS\Strand\Figures\Lick Run MSD Project ID 11x17.mxd at some point in the future. Therefore, the proposed separation of the *priority areas* is not "full separation" but more accurately characterized as "partial separation."

While there was significant discussion about performing full sewer separation as a part of the Wet Weather Strategy, or sizing the proposed storm sewer system to allow for full separation of the entire watershed at some time in the future, it was decided that full separation of the watershed to include the non-priority areas was not a financially feasible option for CSO control. A number of factors support this decision.

1. Cost-Effectiveness

Generally speaking, full separation as a CSO control strategy is rarely selected as the preferred control alternative for large urban communities in this country. Volume II, Section 8 of MSDGC's *CSO Long Term Control Plan (LTCP) Update Report* presents and summarizes MSDGC's alternatives evaluation process that led to the selection of recommended LTCP elements. The results of this analysis consistently show that full separation, while effective at reducing CSO discharges, is very expensive when compared to other alternatives.

Because of the magnitude of the WWIP and the financial burden associated with its implementation, MSDGC needs to prioritize expenditures and strategically direct limited resources in a manner that maximizes the return on investment. The results of a more detailed analysis of the cost implications associated with full separation or sizing the proposed storm sewer system to allow for full separation are included in Section 2.08.

2. Level of Control

The WWIP anticipates a CSO level of control of 85 percent capture for the CSOs represented in the Lower Mill Creek Partial Remedy Plan (LMCPRP), including CSO 005 in the Lick Run Watershed. This standard conforms to the minimum requirements contained in the USEPA CSO Control Policy:

> "The long-term CSO control plan should adopt one of the following approaches…
>
> ii. The elimination or capture for treatment of no less than 85% by volume of the combined sewage collected in the CSS during precipitation events on a system-wide annual average basis."

As stated in Section 1, the June 2011 *Lick Run Green–Ultimate Conditions Model Update Memorandum* predicts the strategic sewer separation approach will remove adequate stormwater flows from the existing CSS to meet the required 85 percent level of control as shown in Table 2.02-2. Therefore, incurring additional costs to upsize proposed infrastructure beyond conformance with existing regulations with no associated increase in the CSO level of control should be considered in the context of the regulatory review and approval process.

Scenarios	1970 Typical Year			
	Inflow (MG)	Overflow (MG)	Underflow (MG)	% Control
Base Conditions (Version 4.0 through December 2010)	1,822	1,090	730	40%
Ultimate Conditions	786	268	518	85%
Difference	**1,036**	**822**	**212**	

Table 2.02-2 Modeled Stormwater Removal and CSO Reduction

3. Level of Service

The proposed strategic sewer separation projects are expected to provide a significant increase in the current level of service provided by the existing CSS. By installing a new parallel stormwater conveyance system sized to convey up to 25 year stormwater flows from the priority areas, accounting for approximately two-thirds of the Lick Run watershed area, MSDGC is providing significant improvement to the overall stormwater and combined sewer drainage systems serving this community.

Modeling efforts to date have shown that large portions of the existing CSS are surcharged during storm events as frequent as a two-year event. The Lick Run system-wide model(s) simulate all combined sewers that are 18-inches in diameter or larger, accounting for approximately 150,000 feet of the Lick Run Watershed's total 358,000 feet of CSS (41 percent). Because the non-priority areas are highly developed upland areas, with a significant portion of the smaller unmodeled combined sewers, nearly all the combined sewers in the priority areas are included in the system-wide models and can provide a direct correlation to the effectiveness of the parallel storm water conveyance system on the CSS level of service.

A comparison was performed evaluating the CSS surcharging pre-sewer separation in the Lick Run existing conditions SWM and against the CSS surcharging post-sewer separation in the Lick Run ultimate conditions SWM. Table 2.02-3 provides a summary of these results.

Critical Duration Storm Events (Percent Modeled CSS Surcharged)					
	6 month	2 year	5 Year	10 Year	25 Year
Pre-Sewer Separation CSS Surcharging	8%	28%	36%	42%	46%
Post-Sewer Separation CSS Surcharging	5%	9%	14%	19%	21%
Percent Reduction in CSS Surcharging	**35%**	**67%**	**60%**	**55%**	**54%**

Table 2.02-3 Modeled CSS Surcharging Pre- and Post-Sewer Separation

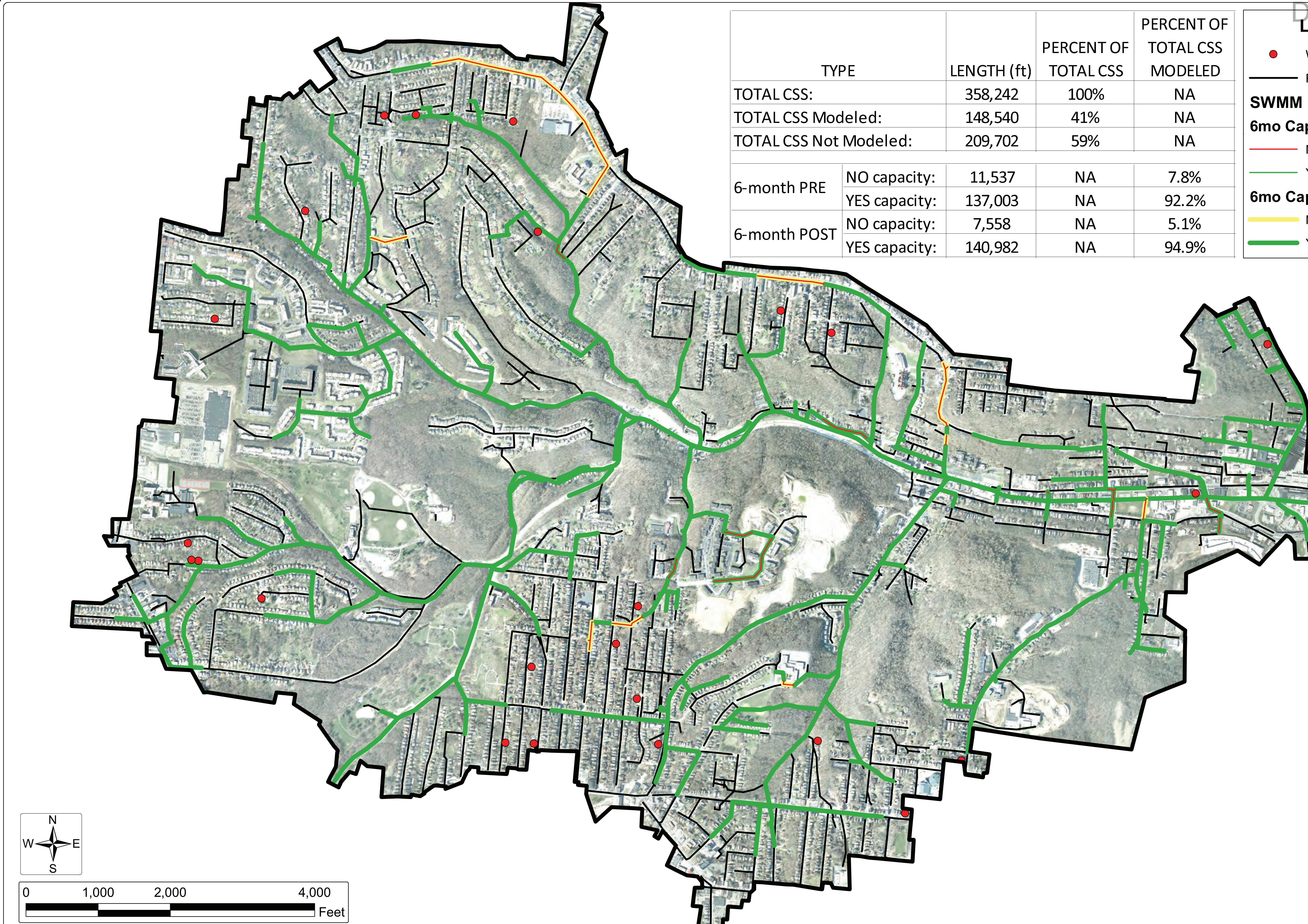
The indication from the results shown in Table 2.02-3 is that greater than a 50 percent increase in CSS LOS can be expected in all modeled storm events greater than a six-month return interval. This further translates to an anticipated decrease of localized flooding, within the sewer separation areas, of greater than 50 percent in all storm events exceeding a six-month return interval. Figures 2.02-13 through 2.02-17 provide a representation of this reduction in CSS surcharging, based on modeled results.

D. Sewer Separation Project Development

The priority areas were originally divided into 12 project areas based on drainage basins, but were ultimately redefined as 14 distinct sewer separation projects. Of these 14 sewer separation projects, Harrison Avenue was divided into Phase A and B to allow for an expedited design and construction schedule of Phase A to coincide with an adjacent CDOTE project. Refer to Table 1.02-1 for the correlation between the original project areas and the current sewer separation projects. Maintenance of traffic, location within the watershed, logical termini, and projected construction cost were considered when ultimately determining the limits of the sewer separation projects.

Table 2.02-4 lists the current sewer separation projects, associated drainage areas, and conveyance lengths as of December 30, 2011. Conveyance lengths include stormwater conveyance (open and closed systems) as well as combined sewer and watermain utility relocations.

TYPE		LENGTH (ft)	PERCENT OF TOTAL CSS	PERCENT OF TOTAL CSS MODELED
TOTAL CSS:		358,242	100%	NA
TOTAL CSS Modeled:		148,540	41%	NA
TOTAL CSS Not Modeled:		209,702	59%	NA
6-month PRE	NO capacity:	11,537	NA	7.8%
	YES capacity:	137,003	NA	92.2%
6-month POST	NO capacity:	7,558	NA	5.1%
	YES capacity:	140,982	NA	94.9%



Legend

- Water In Basement
- Pipes Not In Model

SWMM Pipes

6mo Capacity-PRE

- NO
- YES

6mo Capacity-POST

- NO
- YES

6 MONTH - PRE VS. POST SEWER SEPARATION COMBINED SEWER SYSTEM SURCHARGING

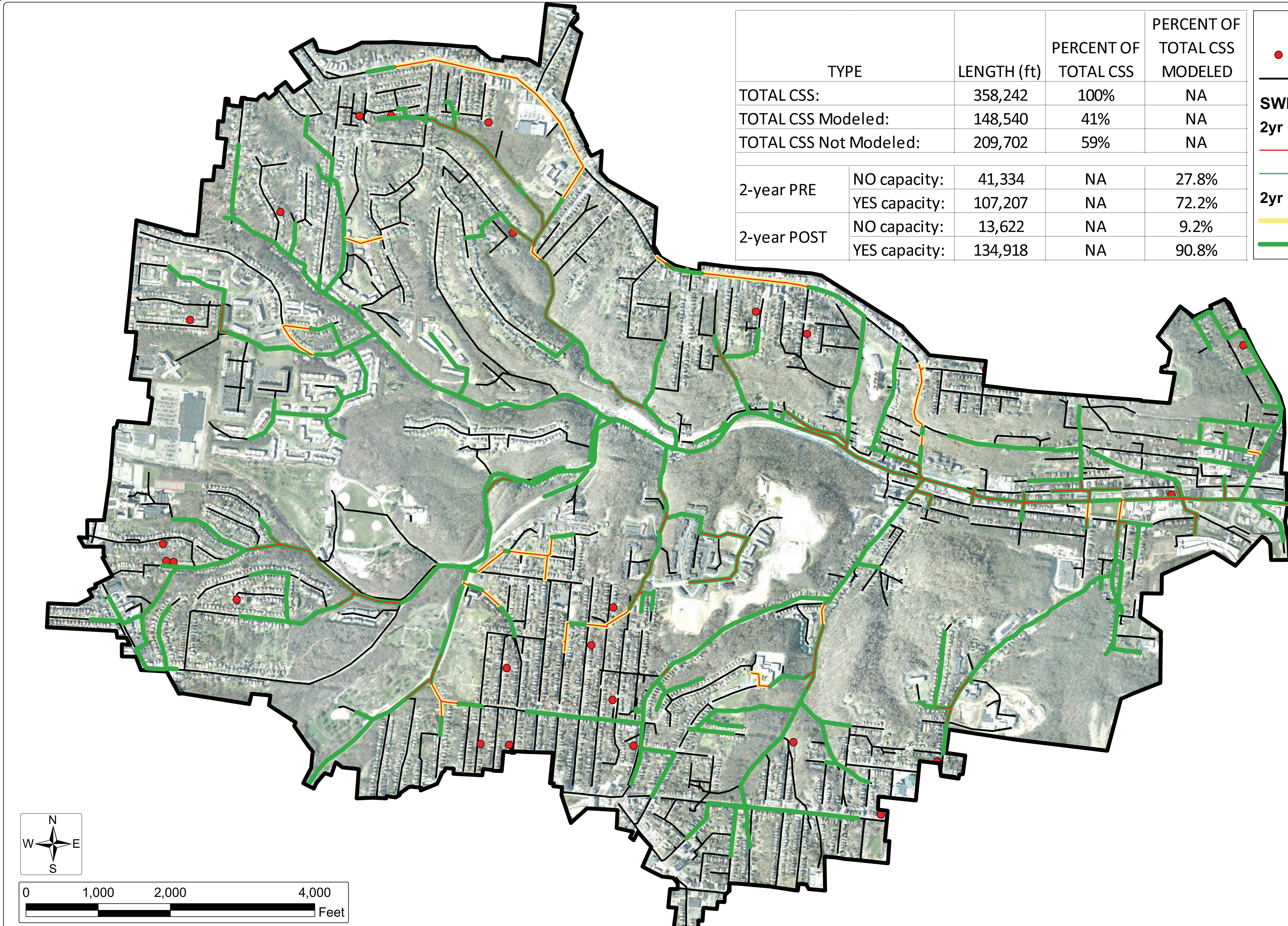
LICK RUN WET WEATHER STRATEGY
METROPOLITAN SEWER DISTRICT OF GREATER CINCINNATI

STRAND ASSOCIATES

3560.018
Figure 2.02-13

Path: S:\CIN\3500--3599\3560\020\Data\GIS\Figures\Figure 3.x - 6 month PRE vs POST capacity analysis.mxd

TYPE		LENGTH (ft)	PERCENT OF TOTAL CSS	PERCENT OF TOTAL CSS MODELED
TOTAL CSS:		358,242	100%	NA
TOTAL CSS Modeled:		148,540	41%	NA
TOTAL CSS Not Modeled:		209,702	59%	NA
2-year PRE	NO capacity:	41,334	NA	27.8%
	YES capacity:	107,207	NA	72.2%
2-year POST	NO capacity:	13,622	NA	9.2%
	YES capacity:	134,918	NA	90.8%



2 YEAR - PRE VS. POST SEWER SEPARATION
COMBINED SEWER SYSTEM SURCHARGING

LICK RUN WET WEATHER STRATEGY
METROPOLITAN SEWER DISTRICT OF
GREATER CINCINNATI

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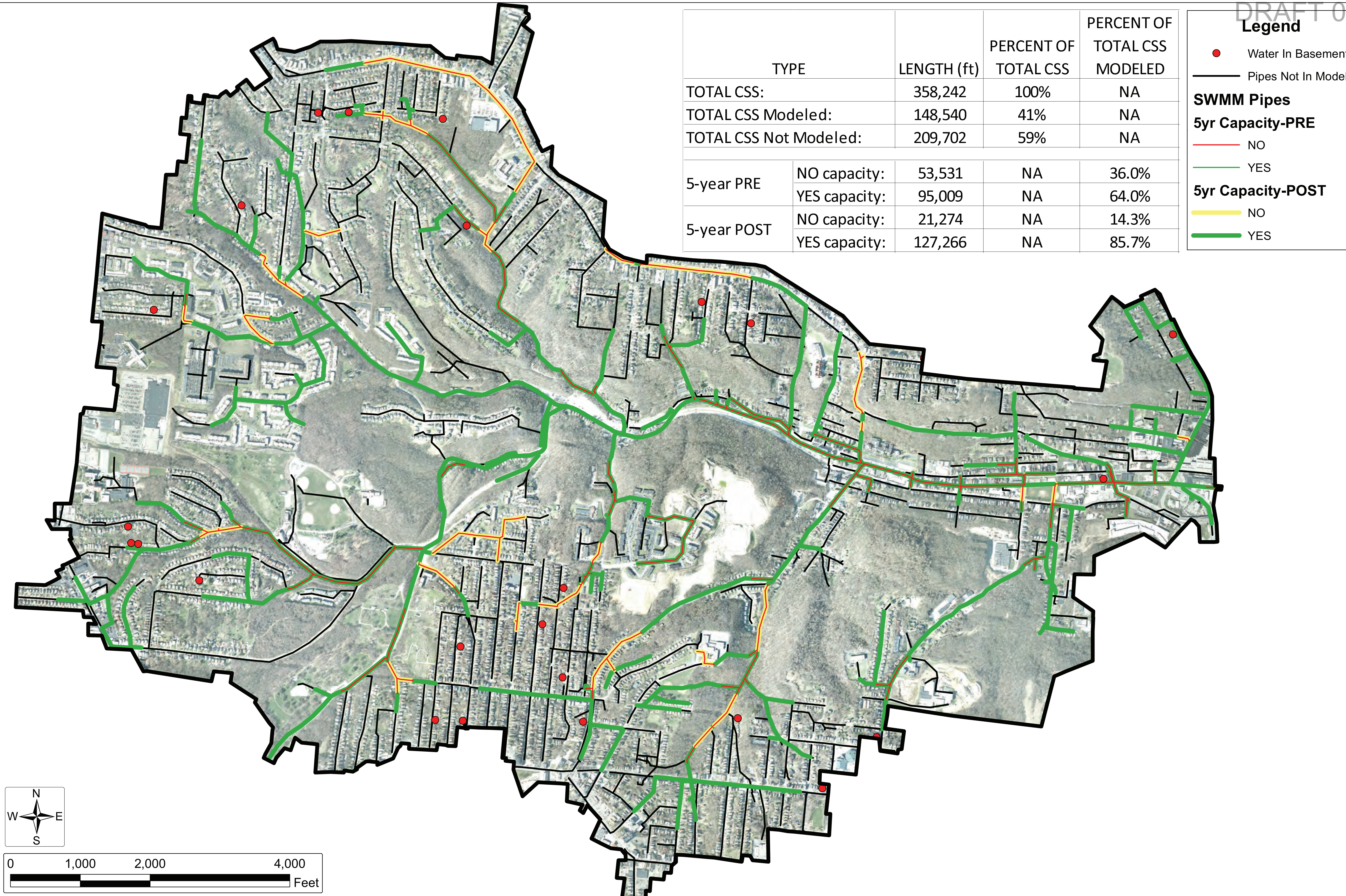
3560.018
Figure 2.02-14

DC RCVD_04/02/2012_47/122

TYPE		LENGTH (ft)	PERCENT OF TOTAL CSS	PERCENT OF TOTAL CSS MODELED
TOTAL CSS:		358,242	100%	NA
TOTAL CSS Modeled:		148,540	41%	NA
TOTAL CSS Not Modeled:		209,702	59%	NA
5-year PRE	NO capacity:	53,531	NA	36.0%
	YES capacity:	95,009	NA	64.0%
5-year POST	NO capacity:	21,274	NA	14.3%
	YES capacity:	127,266	NA	85.7%



5 YEAR - PRE VS. POST SEWER SEPARATION COMBINED SEWER SYSTEM SURCHARGING

LICK RUN WET WEATHER STRATEGY
METROPOLITAN SEWER DISTRICT OF GREATER CINCINNATI

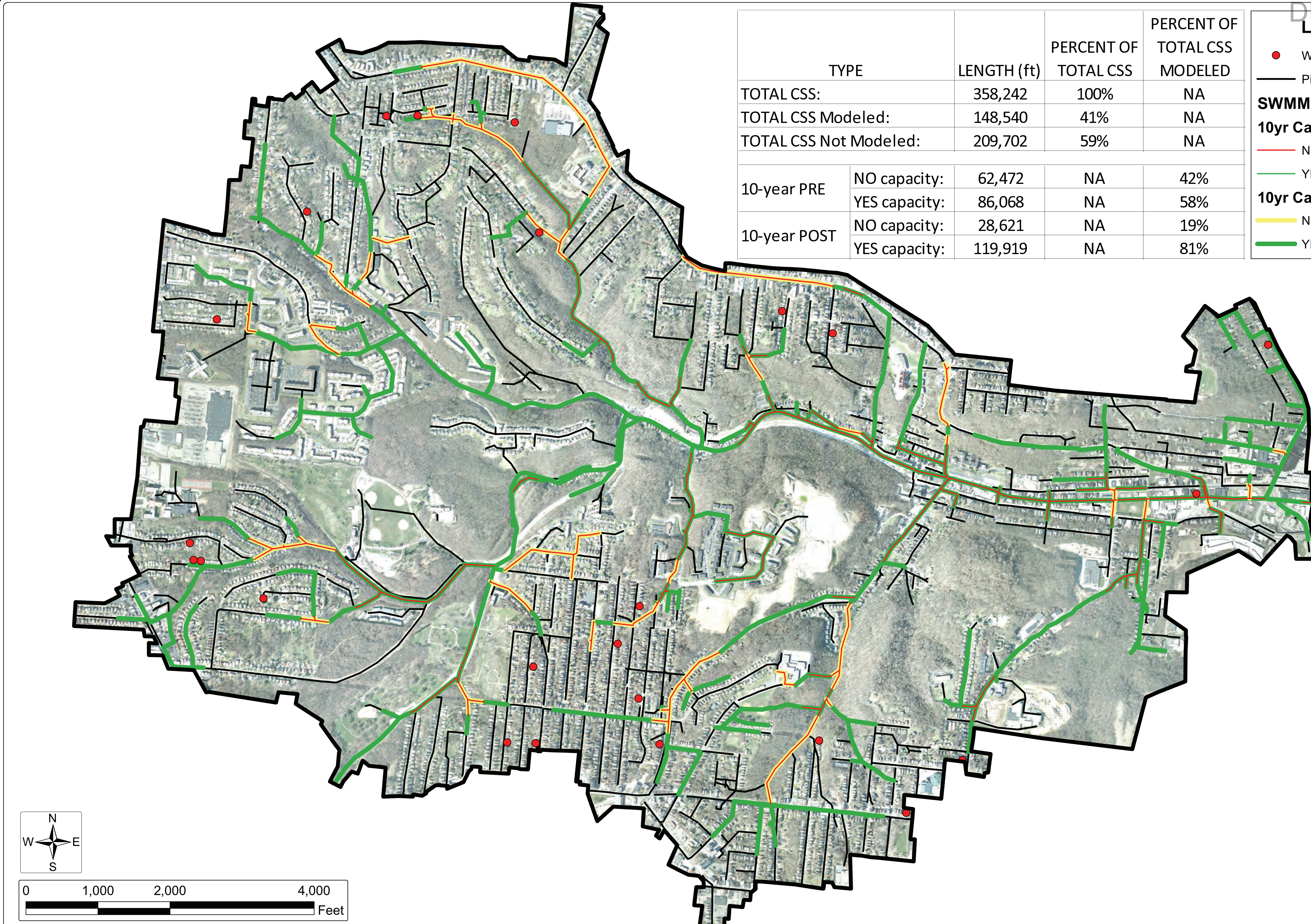
STRAND ASSOCIATES

3560.018
Figure 2.02-15

Path: S:\CIN\3500--3599\3560\020\Data\GIS\Figures\Figure 3.x - 5 year PRE vs POST capacity analysis.mxd

DRAFT 03/30/12

TYPE		LENGTH (ft)	PERCENT OF TOTAL CSS	PERCENT OF TOTAL CSS MODELED
TOTAL CSS:		358,242	100%	NA
TOTAL CSS Modeled:		148,540	41%	NA
TOTAL CSS Not Modeled:		209,702	59%	NA
10-year PRE	NO capacity:	62,472	NA	42%
	YES capacity:	86,068	NA	58%
10-year POST	NO capacity:	28,621	NA	19%
	YES capacity:	119,919	NA	81%



Legend

- Water In Basement
- Pipes Not In Model

SWMM Pipes

10yr Capacity-PRE

- NO
- YES

10yr Capacity-POST

- NO
- YES

10 YEAR - PRE VS. POST SEWER SEPARATION COMBINED SEWER SYSTEM SURCHARGING

LICK RUN WET WEATHER STRATEGY METROPOLITAN SEWER DISTRICT OF GREATER CINCINNATI

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3560.018

Figure 2.02-16

DC RCVD_04/02/2012_49/122

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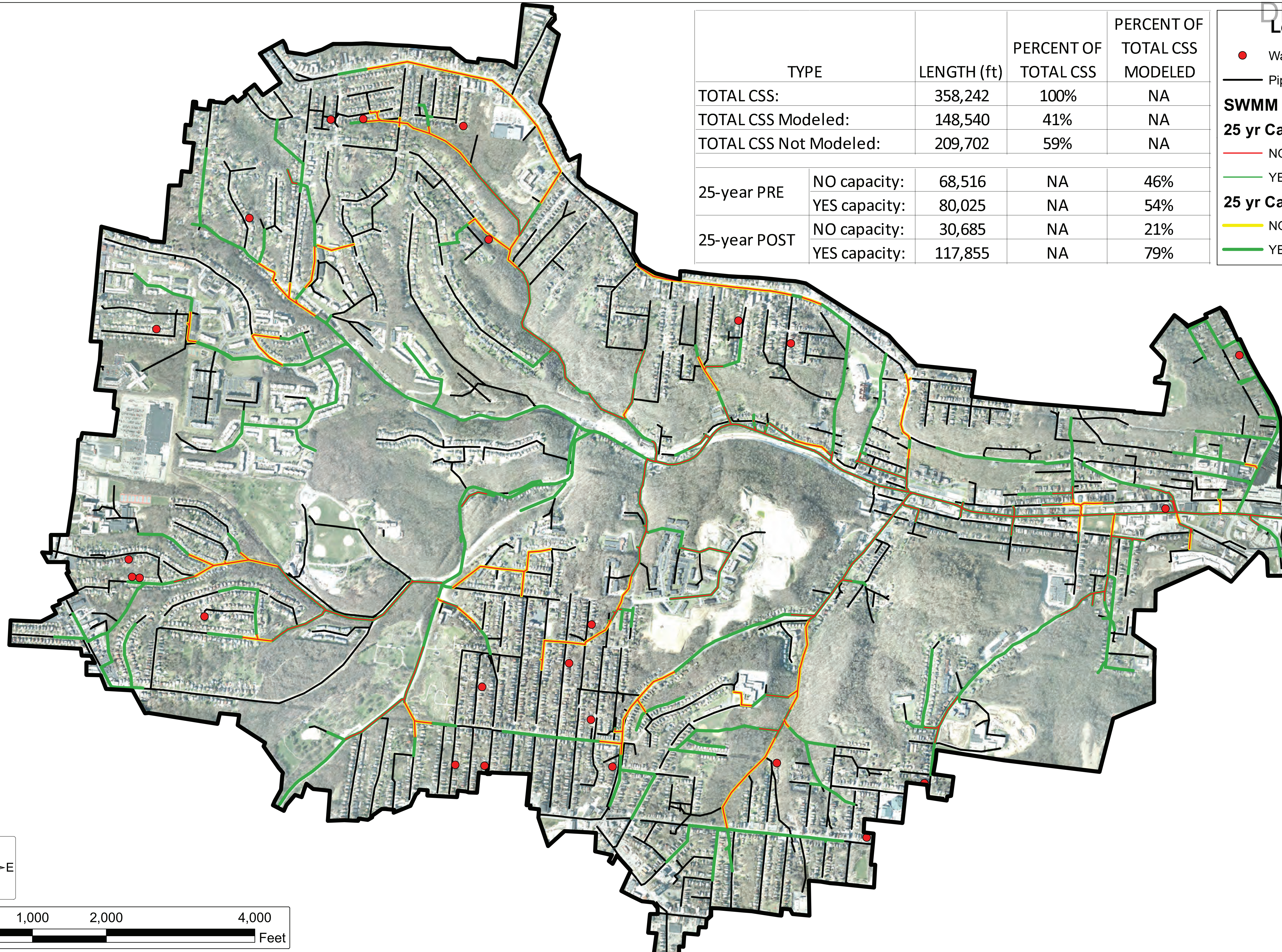
TYPE		LENGTH (ft)	PERCENT OF TOTAL CSS	PERCENT OF TOTAL CSS MODELED
TOTAL CSS:		358,242	100%	NA
TOTAL CSS Modeled:		148,540	41%	NA
TOTAL CSS Not Modeled:		209,702	59%	NA
25-year PRE	NO capacity:	68,516	NA	46%
	YES capacity:	80,025	NA	54%
25-year POST	NO capacity:	30,685	NA	21%
	YES capacity:	117,855	NA	79%



25 YEAR - PRE VS. POST SEWER SEPARATION COMBINED SEWER SYSTEM SURCHARGING

LICK RUN WET WEATHER STRATEGY METROPOLITAN SEWER DISTRICT OF GREATER CINCINNATI

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3560.018
Figure 2.02-17

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Project Name	Project ID	Drainage Area (ac)	Length of Conveyance (LF)
Sunset Avenue, Sunset Lane and Rapid Run Pike	11240010	480	10,800
Rapid Run Early Success Project	11040010	44	3,900
Wyoming and Minion Avenues	11240030	70	4,650
Harrison Avenue Phase A	11240050	36	4,200
Harrison Avenue Phase B	11240050	26	2,100
State Avenue	11240070	12	3,800
White Street	11240090	64	7,000
Quebec Road	11240110	197	8,500
Queen City Avenue Phase 2	11240130	228	8,300
Queen City and Cora Avenues	11240150	146	5,900
Quebec Heights Phase 1	11240170	72	6,600
Quebec Heights Phase 2	11240190	11	1,500
Grand and Selim Avenues	11240210	274	11,500
Queen City Avenue Phase 3	11240230	34	4,700
Westwood Avenue	11240250	11	6,600
Queen City Avenue Phase 1	11240270	107	2,800

Table 2.02-4 Proposed Sewer Separation Projects

2.03 MODELING

Modeling of the proposed storm sewers was initially completed using the HEC-HMS hydrologic software package to develop peak stormwater flows and the StormCAD hydraulic design software to size the pipes. The results were grouped by the 12 project areas and are included in the PEA. Following the redefinition of the project areas into sewer separation projects, these projects were advanced to a preliminary 30 percent design level and beyond. During this advanced design effort, the hydrologic and hydraulic models were refined accordingly.

A. Hydrologic Model

The amount of stormwater discharging from a watershed depends on a number of individual characteristics. The watershed characteristics described in Section 2.02.B, particularly topography, land use, and soil types, as well as degree of saturation, type of drainage system (combined sewers, storm sewers, open channels), and amount of watershed storage available can affect stormwater discharge rates and volumes. The data used in the hydrologic models was obtained from CAGIS and topographic field survey. Projections for future development within the watershed were not included in the delineation of the land use characteristics. The majority of undeveloped tracts within the watershed are under public ownership, conservancy lands, or on steep slopes not considered suitable for urban development. The remaining tracts suitable for future development would be subject to current stormwater management regulations related to pre- versus post-development runoff. These regulations in effect would negate any significant contributions to projected peak flow rates in subcatchment areas from this potential future development.

The hydrologic model completed for the sewer separation projects transitioned from HEC-HMS, initially used as a part of the PEA, to HydroCAD, used as a part of the preliminary 30 percent design of the sewer separation projects. This transition was made primarily because HydroCAD is more flexible with running multiple storm durations at one time to obtain the peak flow at each node and provides the ability to model pond outlet control structures in series. This flexibility becomes important when inputting peak flows into the hydraulic design software used to size the respective storm sewer segments.

Rainfall depths used for the hydrologic analysis were taken from Bulletin 71, *Rainfall Frequency Atlas of the Midwest,* Floyd A. Huff and James R. Angel, 1992. Appropriate Huff rainfall time distributions taken from Circular 173, *Time Distribution of Heavy Rainstorms in Illinois,* Floyd A. Huff, 1990, were applied for the analysis. Note that a Huff 1st Quartile rainfall distribution, which is typical of short duration storm events in the region, was applied for storm durations less than 24 hours. For 24-hour storm durations, a Huff 3rd Quartile rainfall distribution was used.

A critical duration analysis was performed to estimate the storm duration generating the highest peak discharges at the outfall for each proposed sewer segment. The peak flows for the 10-year and 25-year frequency storm events were modeled using the Soil Conservation Service TR-20 method. The storm duration producing the highest peak discharge varied but was typically one hour or less.

B. <u>Hydraulic Model</u>

The hydraulic modeling for the proposed storm sewer projects was completed using StormCAD to determine appropriate pipe sizes, slopes, and invert elevations necessary to meet local design requirements and avoid existing utility conflicts. Input parameters include a model of the existing ground surface, preliminary storm sewer alignments and profiles, pipe material, and structure size information. The peak flows, as determined from the hydrologic model results, were entered at each anticipated change in flow (i.e., at each inlet, catch basin, headwall, and detention basin outfall). The outfall conditions for each sewer segment were input based on expected conditions for both the ultimate connection to the urban VCS and the temporary connection, if applicable, to the existing CSS. The temporary connections and urban VCS models are discussed in more detail in Sections 2.06.C and 3.03.B, respectively.

The modeling was completed based on Stormwater Management Utility Rules and Regulations (SMU Rules and Regulations) and specific guidance provided by the SMU, which are included in the listAppendix C and discussed in Section 2.04. Outputs from the hydrologic and hydraulic models are included in Appendix D.

2.04 DESIGN CRITERIA

In general, storm sewer system designs of this magnitude, and in particular, sewer separation system design, are not common projects for MSDGC. In order to address the unique design and policy implications of this project, a combination of MSDGC, SMU, the Ohio Environmental Protection Agency (OEPA), GCWW, the CDOTE, and Duke Energy guidelines and policies were utilized to design the proposed sewer alignments and profiles.

A. Storm Sewer Sizing

The storm sewers were sized to convey runoff from the priority areas only. This decision was made for the reasons listed in Section 2.02.C.

The proposed storm sewers were designed to provide full-flow capacity for runoff generated from a 10-year frequency storm event and accommodate runoff generated from a 25-year frequency storm event below grade in a surcharged condition, as required by the SMU Rules and Regulations.

B. Design Flow

The anticipated peak flow conveyed from the 10-year frequency storm event must be less than the theoretical capacity of the pipe as calculated from Manning's Equation. Although this is not stated in the SMU Rules and Regulations, this criterion was provided by SMU in review discussions.

C. Velocity

With regard to velocities, the SMU Rules and Regulations state:

> "A minimum velocity of 2.5 feet per second (fps) is recommended to insure self cleaning. The maximum allowable velocity shall be 12 fps unless special materials are included for protection against scouring."

A review of rules and regulations for other local agencies and design recommendations from pipe manufacturers revealed that velocities up to 25 fps are often acceptable for most types of pipe. Because of the steep slopes in the Lick Run Watershed, and potential cost and constructability impacts associated with maintaining velocities below 12 fps, discussions were held with both SMU and MSDGC on this topic. The design criterion resulting from these discussions was a maximum velocity of 20 fps, with keyblocking provided at every pipe joint for pipe segments with velocities in excess of 12 fps. Therefore, the proposed storm sewers were designed to have a minimum velocity of 2.5 fps and a maximum velocity of 20 fps. As the proposed sewer separation projects have advanced in design and cost opinions have been refined, this criterion has added significant cost to the strategic sewer separation element of the Wet Weather Strategy.

D. Hydraulic Losses

A flat head loss of 0.5 feet was assumed at each proposed structure based on guidance provided by SMU. Review comments questioning this assumption were received on the preliminary 30 percent models, but to date the models have not been revised according to SMU directive.

E. Minimum Depth

The proposed storm sewers were designed to have a minimum of 4 feet of cover wherever possible. In some circumstances, 4 feet of cover was not cost-effective or constructible, and consequently was reduced to below 4 feet. However, in no cases was the cover less than 2 feet. In these circumstances where less than 4 feet of cover was provided, ductile iron pipe was specified.

F. Structure Spacing and Inlet Spacing and Capacity

In accordance with SMU's Rules and Regulations, a maximum spacing of 300 feet was used for the placement of access structures along the sewer alignments for pipe diameters up to and including 36 inches and 500 feet for pipe diameters in excess of 36 inches. Manholes were specified for pipe sizes less than 48 inches, and vaults were specified for pipe sizes greater than 48 inches.

As a part of the strategic sewer separation approach discussed under 2.02.C, the inlet spacing and capacity of the existing surface drainage system were not evaluated during the design of the proposed storm sewer system. The objectives of providing an adequate level of CSO control, cost-effectively, while maintaining an equal or greater level of system service, were achieved by maintaining the existing locations and capacity of existing inlets and simply disconnecting them from the combined sewer system and reconnecting to the storm sewer system. As a result of this objective, inlets were reused if possible or replaced in the same general location.

G. Drop Connections at Structures

Structures with a difference in inverts greater than 2 feet between sewer connections are not specifically addressed in the SMU Rules and Regulations; however, ensuing discussions resulted in drop elevations being preferable over steeper slopes and constant structure elevations to keep pipe velocities at a minimum and maintain hydraulic grade line (HGL) design requirements. Outside drop structures are typically installed in sanitary sewer manholes with 2 feet of invert elevation differences, but rarely installed with storm sewer systems because of potential pipe diameters and material types. Several review comments on the preliminary 30 percent storm sewer drawings referenced invert elevation differences at structures; however, the inclusion of these was a result of the aforementioned design requirements.

H. Change in Flow Direction at Structures

Several review comments received on the preliminary 30 percent sewer separation drawings indicated a preference to avoid changes in flow direction of 90 degrees or greater. While this preference is not reflected in the SMU Rules and Regulations, it is based on historical structure maintenance and replacement records. This preference was discussed with reviewing agencies, and the result was structures with 90 degree change in flow direction would be allowed if details designed by a structural engineer are included in the drawings.

I. Horizontal and Vertical Separation from Existing Utilities

The existing underground utility infrastructure consists of a myriad of underground utility pipes and mains, particularly in the central corridor, and they are old and in some cases large. The large diameter existing combined sewer, ranging in diameter from 14.5 feet to 19.5 feet, and several large diameter transmission water mains, ranging in diameter from 24 inches to 42 inches, located along Queen City Avenue and Westwood Avenue were especially critical and received careful consideration. Several of the proposed sewer alignments cross the existing large diameter combined sewer and water mains, and these existing utilities dictated the potential location and depth of the proposed sewers.

In addition to specific design criteria discussed below, the proposed sewer alignments were selected based on a number of factors consistent with typical engineering design. Some of the more significant factors include location of existing right-or-way, maintenance of traffic considerations, and existing subsurface conditions which are discussed below.

The proposed storm sewers were designed to maintain 5 feet of horizontal separation from existing combined and sanitary sewers and 10 feet of horizontal separation from existing water mains wherever possible. The proposed sewers were also designed to maintain 18 inches of vertical separation from all existing utilities wherever possible. In some circumstances, these separation distances required storm sewer designs that were not cost-effective and/or constructible. Discussion regarding required separation distances occurred with MSDGC and other utility companies, which led to the following measures in the proposed storm sewer design:

1. Specifying controlled density fill as the backfill material for proposed storm sewer trenches located within 5 feet of the roadway or beneath sidewalk.

2. Specifying unreinforced concrete caps in locations with less than 18 inches of vertical separation between a proposed sewer and existing utility.

3. Specifying soil stabilization or trenchless installation technologies to protect existing adjacent utilities.

A minimum of 4 feet of horizontal separation was maintained between existing utility poles and proposed pipes and structures. In cases where this separation could not be achieved, the poles were noted as relocated and associated costs were incorporated into the opinions of probable construction cost. Coordination with Duke Energy helped identify transmission and other critical poles to be avoided during construction.

A list of design standards, rules and regulations, and manuals referenced during the design of the proposed sewers are included in Appendix C.

J. Existing Infrastructure Reuse, Removal, or Abandonment

A number of existing structures or pipes were proposed for utilization, in their current condition, as a part of the sewer separation projects. Where structures were proposed for reuse, the condition and design of the existing structure warranted reuse. The reuse of this structure may include coring new connections and abandoning old connections or reusing existing connections with a new pipe. The majority of inlet structures were proposed for replacement and, depending on the location of the existing inlet structure, were proposed to be removed or abandoned in place.

In some circumstances, there were existing combined sewer segments that have been proposed to be converted to storm sewer. In areas where combined sewer service is still necessary, a new smaller combined sewer pipe sized for the reduced combined sewer flows was proposed for installation. The condition of these pipes proposed for conversion must score a 3 or higher in their condition assessment, according to the Memorandum of Understanding (MOU) between MSDGC and SMU, or repairs must be performed before the pipe is utilized as a storm sewer pipe.

Existing inlet leads, storm sewer connections, or other sources of stormwater entering into the existing CSS will be disconnected in the priority areas by either abandonment or removal. In areas where the existing combined sewer is adjacent to a proposed open stormwater conveyance channel, the condition will be assessed for potential mitigation strategies to prevent infiltration.

K. Geotechnical Considerations

A preliminary geotechnical exploration, focusing on the priority areas and the central corridor, was performed and documented in a report completed in April 2010. Recommendations included in the report were based on field reconnaissance and a review of 71 new test borings and 96 pertinent historical test borings. Figure 2.04-1, which is also included in the *Preliminary (Stage 1A) Geotechnical Exploration* report found in Appendix A, shows the location of the borings throughout the watershed.

Figure 2.04-1 Test Boring Locations in Lick Run Watershed

The following items provide a summary of the observations and recommendations presented in the report:

1. General Utility Excavation:

   a. Variety of materials (fill, sediment, lakebed soils, colluvium, glacial soils, residual soils, and bedrock).
   b. Unsuitable soils will most likely require undercuts in some locations.
   c. Temporary shoring of excavations (sandy soils, soft clays, and poor fill).
   d. Groundwater will most likely be encountered in some locations and require dewatering.
   e. Unweathered bedrock excavation requiring hoe rams, ripping teeth, rock saws, and/or blasting.

2. Utility difficulties/obstacles:

   a. Steep hillsides (oversteepened fill slopes and colluvial slopes):
      (1) Depict signs of creep or instability.
      (2) Require deepening of sewer into stable ground.
      (3) Work in short sections, where sewers cross skewed or parallel to slope contours, to minimize instability effects on the slope.

b. Roadways are congested with other utilities and shoring will be necessary.

c. Nearby retaining walls and structure foundations will require shoring of structures and trenchless installation methods where alignments pass beneath structures/walls.

These recommendations and other information included in the Geotechnical Exploration Report were used to avoid or minimize excavation in bedrock or unsuitable soils, where possible.

2.05 DESIGN ELEMENTS

The Wet Weather Strategy was developed and refined as a holistic approach comprised of multiple elements to achieve the desired goals; primarily, CSO volume reduction. In the initial stages of the project it was assumed the strategic sewer separation and urban VCS elements would be completed concurrently. Preliminary models, design, and costs reflected this assumption. However, as the Wet Weather Strategy advanced, a decision was made to move forward with the design and construction of the sewer separation projects ahead of the urban VCS. The two key factors that influenced this decision were the aggressive timeline laid out in the consent decree and the general state of the economy over the past three years. By constructing the proposed sewer separation projects as soon as possible, MSDGC could not only begin working towards meeting the requirements of the consent decree but also take advantage of favorable bids resulting from the economic climate. This section focuses on noteworthy aspects and features of the strategic sewer separation.

A. Temporary Connections

A key outcome of the decision to advance the sewer separation projects ahead of the urban VCS is the need to temporarily connect the proposed storm sewers to the existing CSS. These temporary connections will occur at the downstream end of the proposed storm sewer projects and be in place until the urban VCS is operational. At the point the VCS is operational, the proposed storm sewers would be disconnected from the CSS and connected to the urban VCS. Many of the proposed temporary connections are located near Queen City Avenue and Westwood Avenue in the vicinity of the existing large diameter combined sewer previously mentioned. The existing large diameter combined sewer is made of brick and was constructed early in the 20th century, so wherever practical, the temporary connections were made at structures upstream from this sewer to minimize disturbance and direct connections to it. However, a number of the temporary connections to the large diameter existing combined sewer were unavoidable and are anticipated to be direct connections to this sewer.

The temporary connections have been included in the modeling, design, and cost opinions for the sewer separation projects as a part of the intermediate 30 percent design, whenever applicable. Table 2.05-1 lists the temporary connections by applicable sewer separation project and Figure 2.05-1 shows the location of the temporary connections within the watershed.

Sewer Separation Project	Proposed Storm Sewer Diameter	Existing Sewer
Queen City Avenue Phase 1	4-foot by 14-foot box conduit	14-foot diameter brick sewer
Quebec Road	72 inch	8.5-foot diameter brick sewer
White Street	48 inch	14-foot diameter brick sewer
Grand and Selim Avenues	91-inch by 58-inch HERCP	19.5-foot diameter brick sewer
Harrison Avenue Phase A	42 inch	19.5-foot diameter brick sewer
Harrison Avenue Phase B	30 inch	2-foot diameter VCP sewer
State Avenue	24 inch	4.5-foot diameter brick sewer

Table 2.05-1 Temporary Connections

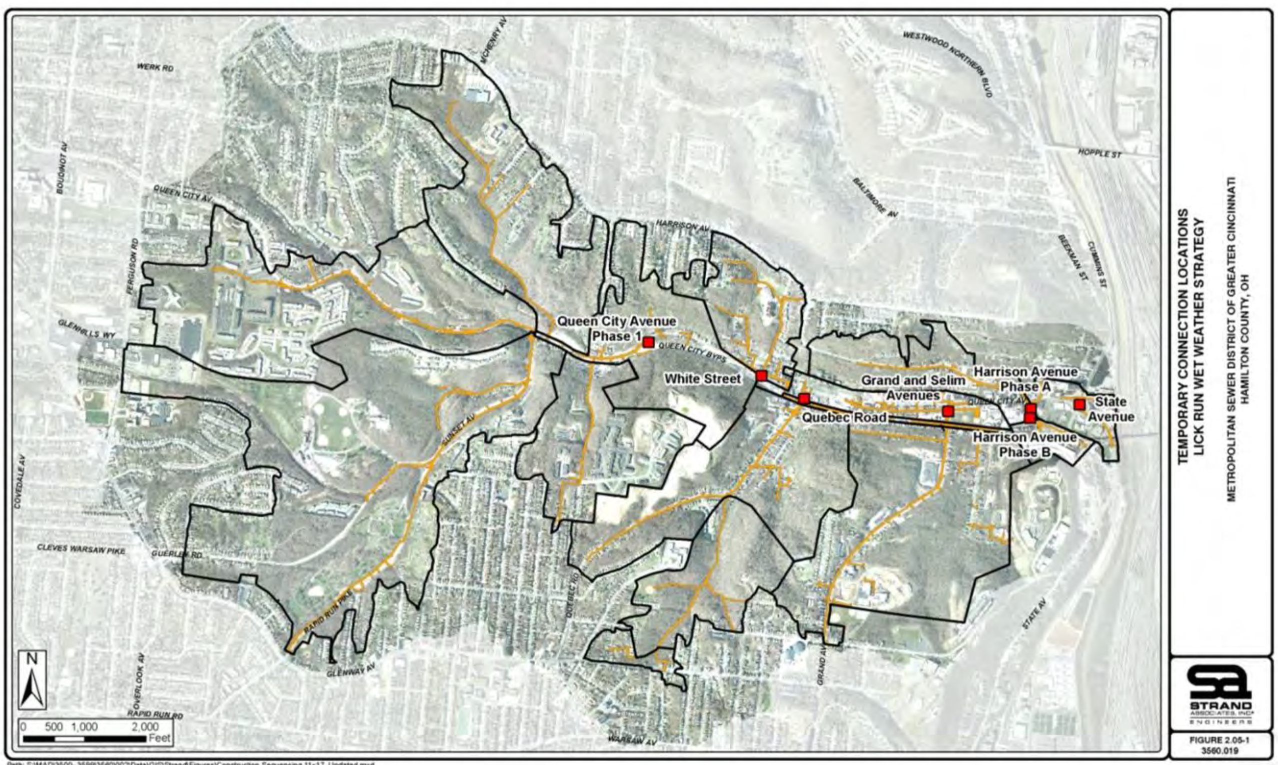

Figure 2.05-1 Temporary Connections

B. Open Channel Conveyance

1. Quebec Heights Phase 1 (also referred to as Glenway Woods)–A review of this catchment area revealed the characteristics are favorable for an open channel conveyance system. An existing ravine runs throughout the project limits, and the majority of the property is owned and maintained by the Cincinnati Parks Board. A number of elements, including geotechnical conditions, existing vegetation, disturbance limits, associated required easements, as well as construction costs and impacts, were compared for both an open and closed system. As of

December 30, 2011, the preferred alternative for advancement to final design is an entirely open channel option. While the main open channel alignment proposed for construction is approximately is 3,000 feet, the total open channel conveyance length of all reaches in this project area are approximately 5,600 feet. Figure 2.05-2 shows the open channel concept currently being designed.

Figure 2.05-2 Quebec Heights Phase 1 Concept Plan

2. Queen City and Cora Avenues R/W Sewer Separation (also referred to as Fenton Avenue)–This project area was identified as another opportunity to evaluate open channel conveyance because of the presence of a historic stream, the existing topography, and land use in the project area. The historic stream was replaced by a system of inlets and pipes that conveyed runoff to the CSS. An alternatives analysis concluded that a hybrid system of approximately 2,800 lineal feet of open channel and approximately 2,400 lineal feet of closed conduit is the best option. Figure 2.05–3 shows the concept plan.

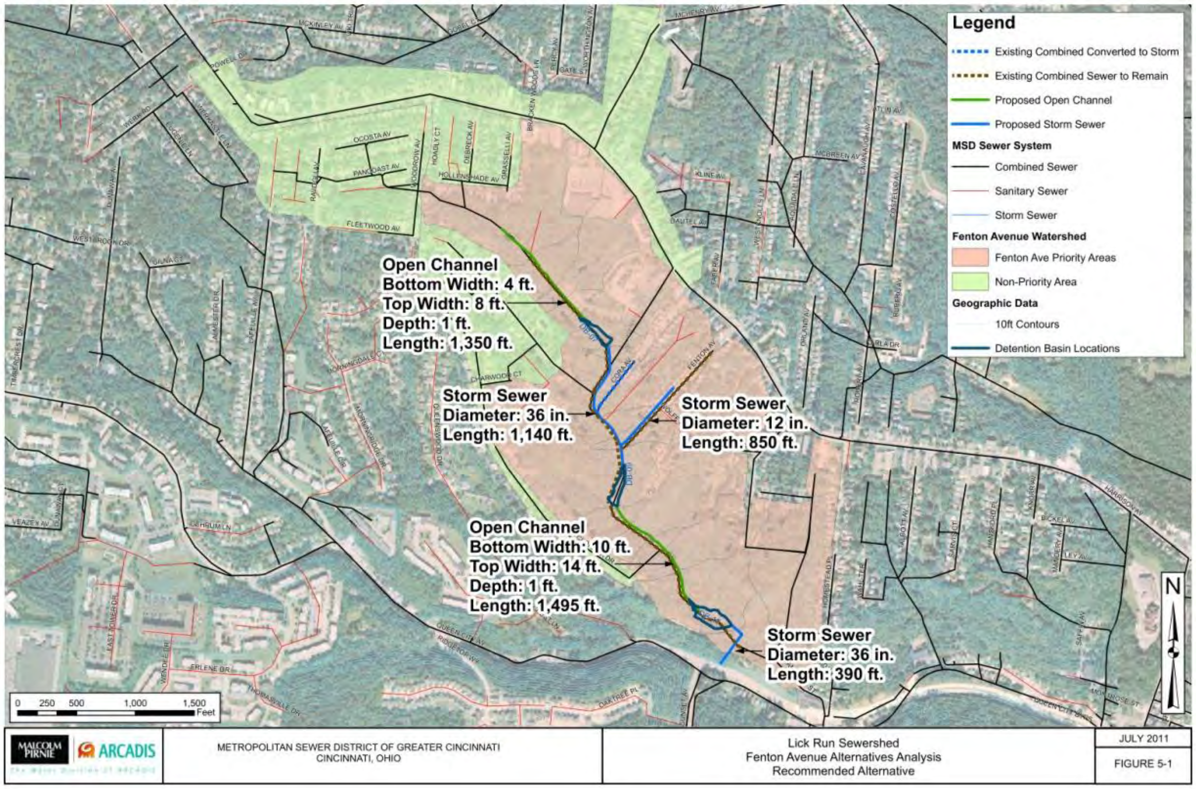

Figure 2.05-3 Queen City and Cora Avenues Concept Plan

B. <u>Detention Basins</u>

As the Wet Weather Strategy was developed, detention features were considered to both reduce peak flows, therefore potentially reducing proposed storm sewer sizes, and provide stormwater quality benefits. Identification of potential detention features focused on existing stormwater detention basins, existing depressions, and proposed basins in strategic locations where existing terrain and features would allow for an efficient application. A number of basins were evaluated from both a water quantity and water quality perspective, and the result was a recommendation to proceed with including nine detention basins in the sewer separation project areas. Of these nine basins, seven will be constructed with various sewer separation projects, DB 14 (referred to as the open water forebay) will be constructed with the urban VCS, and DB Guerley is being advanced by SMU independent of the Wet Weather Strategy. It should be noted that the nine detention basins will all ultimately be connected to the proposed storm sewer system. Figure 2.05-4 shows these detention basins, with the exception of DB 14, which is the focus of Section 3.05.A. Estimated pollutant load reductions associated with the detention basins are listed in Section 3.03.C, and associated costs are discussed in Section 4.

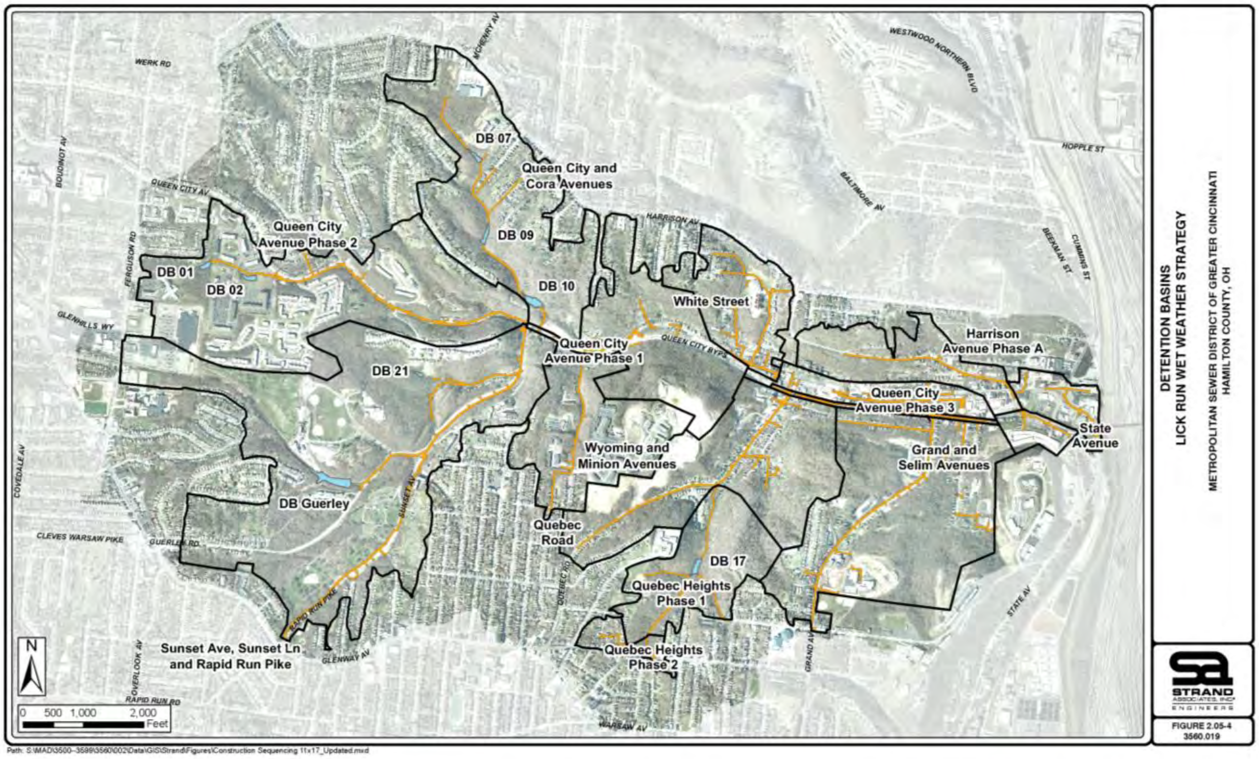

Figure 2.05-4 Detention Basins

C. Early Success Projects

In an effort to design and construct sustainable projects early in the implementation stage of Phase 1 of the WWIP, a range of potential green infrastructure projects as identified to capture stormwater runoff and reduce volumes into the CSS. These green infrastructure projects include site-specific stormwater management strategies and sustainable infrastructure features that serve multiple purposes including:

1. Water quantity benefits or stormwater runoff volume reductions through infiltration and evapotranspiration.
2. Water quality benefits by filtering stormwater runoff through green infrastructure.
3. Public education by building community support for green infrastructure through stakeholders and property owners within the Lick Run Watershed.
4. Immediate and long-term benefits for both MSDGC and the community.

The initial planning phase resulted in the identification of green infrastructure opportunities for ten ESPs, the majority of which were located within the Lick Run Watershed. A variety of green infrastructure features were recommended for the project locations including bioinfiltration basins, bioswales, permeable pavements, green street features, reforestation, and extended detention. Figure 2.05-5 presents several ESP opportunities within the Lick Run Watershed. Conceptual plans for many of the ESPs are included in Appendix L.

Figure 2.05-5 Early Success Projects

After the opportunities for ESPs were identified, MSDGC started implementing several of the projects, with construction completed on two projects in 2010, construction completed on two projects in 2011, construction scheduled to begin on two other projects in 2011, and the remaining projects to be constructed in 2012. The list below provides a brief summary of the ESPs that MSDGC has implemented or plans to implement within the Lick Run watershed.

1. St. Francis Apartments

The St. Francis Apartments along Queen City Avenue had two under-utilized parking lots. As a result, MSDGC identified this as an opportunity to convert the impervious surfaces of these parking lots to vegetative green infrastructure features. The project consisted of the construction of two large-scale bioinfiltration basins totaling approximately 7,000 square feet in surface area and two community garden areas for tenants of the apartment complex. The bioinfiltration basins capture stormwater runoff from approximately 3 acres, including a third remaining parking lot tributary to the basins. Stormwater runoff is filtered, absorbed, and infiltrated in the basins and will ultimately be conveyed to the proposed storm sewer system as part of the Wet Weather Strategy. The construction of the St. Francis Apartments ESP was completed in 2010.

2. Immanuel Church

The Immanuel Church along Queen City Avenue had nearly 7,500 square feet of rooftop directly connected to the CSS via downspouts. MSDGC identified the opportunity to convert existing lawn space in front of the church to a bioswale to capture a large portion of the stormwater runoff from the roof. The bioswale consisted of approximately 320 square feet in surface area, capturing stormwater runoff from approximately one-quarter acre including that area which is from the rooftop of the church. Stormwater runoff that flows from the bioswale will ultimately be conveyed to the proposed storm sewer system as part of the Wet Weather Strategy. The construction of the Immanuel Church ESP was completed in 2010.

3. Rapid Run Park

The Rapid Run Park is located along Rapid Run Pike and is owned and maintained by the Cincinnati Park Board. MSDGC has developed a detailed green infrastructure concept plan for the park that includes a combination of several stormwater BMPs that will demonstrate to the community, in a visible and tangible way, how green infrastructure can integrate into the landscape and produce long-term sustainable results.

These site-specific solutions include the following:

a. Two large-scale bioswales to slow, convey, reduce, and cleanse stormwater runoff along Rapid Run Pike.

b. Bioinfiltration areas throughout the park property to reduce and cleanse stormwater runoff from the park.

c. Step pools to slow stormwater runoff in the ravine on the south side of Rapid Run Pike.

d. Contour infiltration plantings to slow and reduce stormwater runoff from existing hillsides and streets.

e. Reforestation to reduce and cleanse stormwater runoff throughout the park north of Rapid Run Pike, within the contour infiltration planting south of Rapid Run Pike, and at the top of the hillside south of Rapid Run Pike.

f. Stormwater conveyance to reduce the runoff from Rapid Run Park and the pond entering the combined system and direct the runoff to the proposed bioswales.

These stormwater BMPs will slow stormwater velocity, reduce water quantity, and improve quality by ponding, capturing, and infiltrating the stormwater in the park and along Rapid Run Pike. This runoff is generated by impervious surfaces such as parking lots, Rapid Run Pike road, the Cincinnati Recreation Commission ball fields, and steep hillsides throughout Rapid Run Park and along Rapid Run Pike. This project is in the design phase and construction is scheduled to begin in 2012.

4. San Antonio Church

This ESP is located on the corner of Queen City Avenue and White Street on the northwestern edge of the central corridor. The project includes two areas of pervious paver parking stalls, four small bioinfiltration areas in the existing parking lot, and a modified driveway apron at the entrance to the church on White Street. Design of this project is complete and construction is anticipated to begin in late 2011.

5. Harrison Avenue Green Improvements

MSDGC is collaborating with CDOTE to include green improvements in the planned realignment for Harrison Avenue, scheduled to begin construction in 2012. The project includes a bioretention planter feature at Tremont Avenue. Design of this project is nearly complete, and construction of the feature will begin in 2012 and be finalized upon completion of the roadway improvement project.

2.06 BENEFITS

A. Ultimate Conditions (Connection to Urban VCS) Model

Similar to the proposed storm sewer modeling, the model of the existing CSS in the Lick Run Watershed has been refined over time. The SWM, covering the entire Mill Creek WWTP service area, was originally developed for MSDGC's LTCP. In August 2007, a model of the Lick Run sewershed was developed from the SWM. The model parameters were adjusted using flow data collected in 2007 and the model results were compared with three observed storms to validate calibration. The results are shown in Table 2.06-1.

Storm	Peak Flow (mgd)		Difference	Total Volume (mil gal)		Difference
	Observed	Model		Observed	Model	
Oct 16 to 18, 2006	333	377	13%	122	107	-12%
Oct 26 to 28, 2006	291	292	0%	118	105	-11%
Dec 31, 2006 to January 1, 2007	271	232	-14%	46	41	-11%

XCG Consultants, Inc.

Table 2.06-1 Validation of Model Calibration

The 2007 Lick Run model was modified to include elements of the Wet Weather Strategy, including the proposed sewer separation, urban VCS, downspout disconnection, and detention, in an effort to determine the estimated potential reduction in CSO volume. This model was subsequently updated to include a fixed maximum and dynamic underflow, proposed storm sewer sizes and alignments consistent with the 30 percent design, detention basins anticipated to be included in the proposed storm sewer projects, and real time control at the outfall to Mill Creek. Table 2.06-2 presents results of the systemwide modeling efforts.

Scenarios	1970 Typical Year			
	Inflow (MG)	Overflow (MG)	Underflow (MG)	% Control
Base Conditions (Version 3.1 through December 2007. No real time control)	1,856	1,523	333	18%
Base Conditions (Version 4.0 through December 2010. Including real time control)	1,822	1,090	730	40%
Ultimate Conditions of Wet Weather Strategy	786	268	518	85%
Total Reduction (Base Conditions Version 4.0)	**1,036**	**822**		

Table 2.06-2 SWM Model Results

The new storm sewers and urban VCS will remove a significant amount of stormwater from the existing CSS, which will free up capacity and reduce hydraulic grade line elevations in the large diameter brick sewer in the central corridor as well as tributary combined sewers. This will not only reduce the CSO volume at CSO 005 but also improve flooding, basement back-ups, and other associated problems. As a result, the sewer separation projects and urban VCS, in tandem, are expected to provide a greater level of flood control, particularly in the central corridor, and reduce basement back-ups. These benefits are in addition to the anticipated CSO reduction.

B. Percent Effective Values for Strategic Evaluation and Planning

Percent effective values were used in the Lick Run model to represent the anticipated volume of stormwater removed from the existing CSS in the priority areas. These values were based on existing CAGIS information including impervious area, land use, topography, and soils. A high percent effective number was used in undeveloped, pervious areas and in newer neighborhoods constructed with separate storm sewer and sanitary sewer systems, both systems currently discharging to the existing combined sewer. Lower percent effective values were used in developed areas with private parking lots continuing to drain to the CSS, downspouts directly connected to the combined system, or large buildings that may be internally drained. Detailed analysis by land use and impervious area was not completed for each subcatchment in the priority areas because of the lack of detailed impervious area information. However, a detailed analysis of pilot areas, highlighted below, indicated that generally the percent effective values were conservative.

A more detailed, pilot impervious area evaluation was completed for five subcatchment areas. This pilot evaluation included the development of a precise impervious area shapefile in geographical information system (GIS), a breakdown of the types of impervious area in the respective subcatchment, analysis of had a total impervious area of 8.05 acres and a total pervious area of 80.25 acres, which amounts to 9.1 percent impervious area. It was estimated the proposed sewer separation would capture stormwater runoff from 3.46 acres of impervious area and 80.25 acres of pervious area, representing 94.8 percent of the total subcatchment area. The acreage of pervious and impervious areas removed was then used to determine the percent of stormwater no longer entering the CSS from the respective subcatchment and ultimately develop the percent effectiveness of the proposed sewer separation

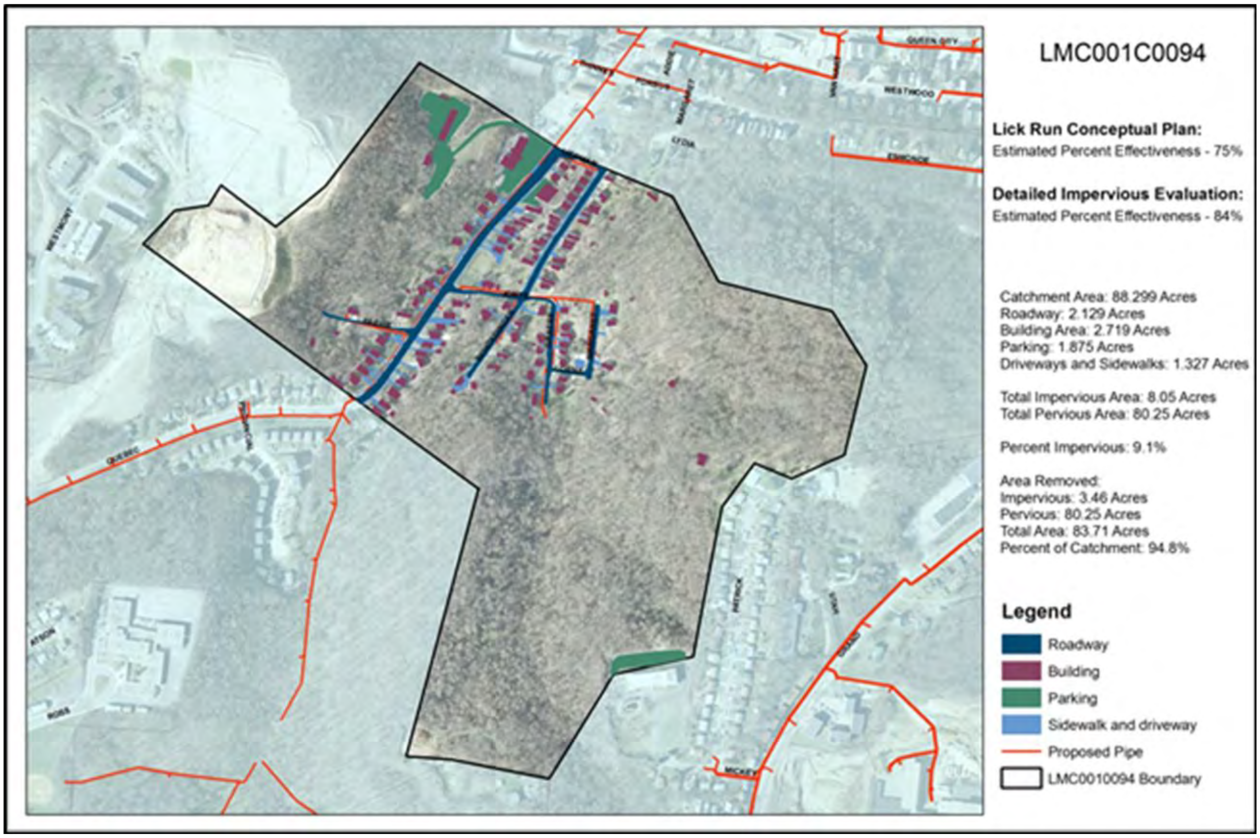

Figure 2.06-1 Detailed Impervious Evaluation

Table 2.06-3 presents the results of this analysis for each of the five subcatchments. The detailed impervious evaluation figures for the other subcatchments can be found in Appendix K.

Subcatchment ID	Conceptual Report	Detailed Impervious Evaluation
LMC001C0044x	90%	95%
LMC001C0094	75%	84%
LMC001C0177	70%	80%
LMC001C0177C	70%	66%
LMC001C0225	60%	69%

Table 2.06-3 Estimated Percent Effective Numbers

Subcatchment ID	Conceptual Report	Detailed Impervious Evaluation
LMC001C0044x	90%	95%
LMC001C0094	75%	84%
LMC001C0177	70%	80%
LMC001C0177C	70%	66%
LMC001C0225	60%	69%

Table 2.06-3 Estimated Percent Effective Numbers

C. Temporary Connections (Connection to Existing CSS) Model

As was previously noted, construction of the urban VCS is expected to begin after completion of the sewer separation projects. Consequently, the ultimate conditions model was modified to determine the impact of the temporary connections if they were installed in phases. The modeling effort shows that the HGL along the Lick Run trunk sewer for each temporary connection scenario is comparable and remains either similar to or lower than the base conditions HGL throughout each of the construction phases. A select number of temporary storm sewer connections are affected by the high combined sewer HGL that is present in the base conditions model, as well as future conditions simulations. In most cases, however, the combined sewer HGL is slightly lower for the future conditions than the base conditions because of timing of the peak flows entering the trunk sewer via the proposed sewer separation and temporary connections.

Even in the temporary condition, the new storm sewers will provide additional capacity to convey stormwater flows upstream of the temporary connection locations. In essence, the new storm sewers will comprise a parallel conveyance system which will reduce flow and HGL elevations in the existing CSS tributary to the large diameter sewer. As a result, basement back-ups are expected to be alleviated in the temporary condition. It should be noted that although the inlet capacity of the existing surface drainage system in the priority areas was not reevaluated, some existing inlets will be replaced because of structural damage or deeper invert elevations. This, combined with the additional capacity of the new storm sewers, should also alleviate localized flooding.

The model results also indicate that the overflow is the same or slightly lower in the phased temporary connections scenarios as compared to the base conditions. Tables 2.06-4 through 2.06-7 summarize the overflow statistics for the base condition and each of the temporary connection scenarios, using the four storm events listed. The percent control for all scenarios is based on the wet weather inflow volume.

Scenarios	10-Year, 1-Hour Storm			
	Inflow (MG)	Overflow (MG)	Underflow (MG)	% Control
Base Conditions (Version 4.0 through December 2010)	119	112	8	6
Temp. Connections–Phase I Conditions	118	112	7	6
Temp. Connections–Phase II Conditions	119	111	7	7
Temp. Connections–Phase III Conditions	118	111	7	7

Table 2.06-4 Overflow Statistics for 10-Year, 1-Hour Storm

Scenarios	25-Year, 1-Hour Storm			
	Inflow (MG)	Overflow (MG)	Underflow (MG)	% Control
Base Conditions (Version 4.0 through December 2010)	145	137	8	6
Temp. Connections–Phase I Conditions	145	137	8	6
Temp. Connections–Phase II Conditions	144	136	8	6
Temp. Connections–Phase III Conditions	144	136	7	6

Table 2.06-5 Overflow Statistics for 25-Year, 1-Hour Storm

Scenarios	10-Year, 24-Hour Storm			
	Inflow (MG)	Overflow (MG)	Underflow (MG)	% Control
Base Conditions (Version 4.0 through December 2010)	270	255	15	6
Temp. Connections–Phase I Conditions	270	255	15	6
Temp. Connections–Phase II Conditions	270	255	15	6
Temp. Connections–Phase III Conditions	271	255	16	6

Table 2.06-6 Overflow Statistics for 10-Year, 24-Hour Storm

Scenarios	25-Year, 24-Hour Storm			
	Inflow (MG)	Overflow (MG)	Underflow (MG)	% Control
Base Conditions (Version 4.0 through December 2010)	326	309	17	5
Temp. Connections–Phase I Conditions	325	309	16	5
Temp. Connections–Phase II Conditions	325	309	16	5
Temp. Connections–Phase III Conditions	325	309	16	5

Table 2.06-7 Overflow Statistics for 25-Year, 24-Hour Storm

2.07 SCHEDULE

A. Design Schedule

As mentioned in Section 2.03, the sewer separation projects were advanced to a preliminary 30 percent level of design following the PEA. Although design drawings were developed, the primary purpose of this effort was to develop a refined OPCC. The preliminary 30 percent drawings and associated modeling were submitted to MSDGC and other reviewing agencies, including SMU, CDOTE, GCWW, and Duke Energy, for review. Table 2.07-1 lists the preliminary 30 percent submittal dates and current project names.

Project Name	Date
Sunset Avenue, Sunset Lane and Rapid Run Pike	July 27, 2010
Wyoming and Minion Avenues	November 24, 2010
Harrison Avenue Phase A	September 28, 2010
Harrison Avenue Phase B	September 28, 2010
State Avenue	October 4, 2010
White Street	October 14, 2010
Quebec Road	August 9, 2010
Queen City Avenue Phase 2	November 24, 2010
Queen City and Cora Avenues	November 24, 2010
Quebec Heights Phase 1	August 18, 2010
Quebec Heights Phase 2	August 18, 2010
Grand and Selim Avenues	August 27, 2010
Queen City Avenue Phase 3	September 22, 2010
Westwood Avenue	September 16, 2010
Queen City Avenue Phase 1	November 3, 2010

Table 2.07-1 Preliminary 30 Percent Submittals

Subsequent to the preliminary 30 percent submittals, the sewer separation projects advanced on different schedules. Refer to Table 2.07-1 and Section 4.02 for more information on the current level of design for each project. It should be noted that the Harrison Avenue Phase A Sewer Separation project is at final design because it will be constructed in conjunction with the CDOTE's roadway improvement project.

B. Construction Schedule

The current phasing of the estimated construction schedule for the sewer separation projects considers maintenance of traffic and temporary connections to the existing CSS. To maintain adequate traffic flow during construction, major roadways, such as Sunset Avenue, Quebec Avenue, and Grand Avenue, are scheduled for construction in different phases. At this time, the estimated construction schedule assumes a 12-month duration for each project, with the exception of Queen City Avenue Phase 1, which has a 6-month duration. Detailed design and construction schedules will be developed for each project after completion of the turnover process. Figure 2.07-1 shows the estimated construction schedule for the sewer separation projects.

2.08 VALUE ENGINEERING STUDY AND EVALUATIONS

The January 2011 *Value Engineering Study* (VE Study) confirmed the technical feasibility of the Wet Weather Strategy and identified potential opportunities to enhance the value of the proposed strategy in terms of its functionality and cost. The primary potential opportunity presented is an alternate method of sewer separation where runoff from relatively small storm events would be collected and conveyed by the proposed separate storm sewer system, with flow from larger storms diverted to the existing CSS for conveyance to Mill Creek WWTP. The intent is to meet the required level of CSO control while downsizing new infrastructure investments.

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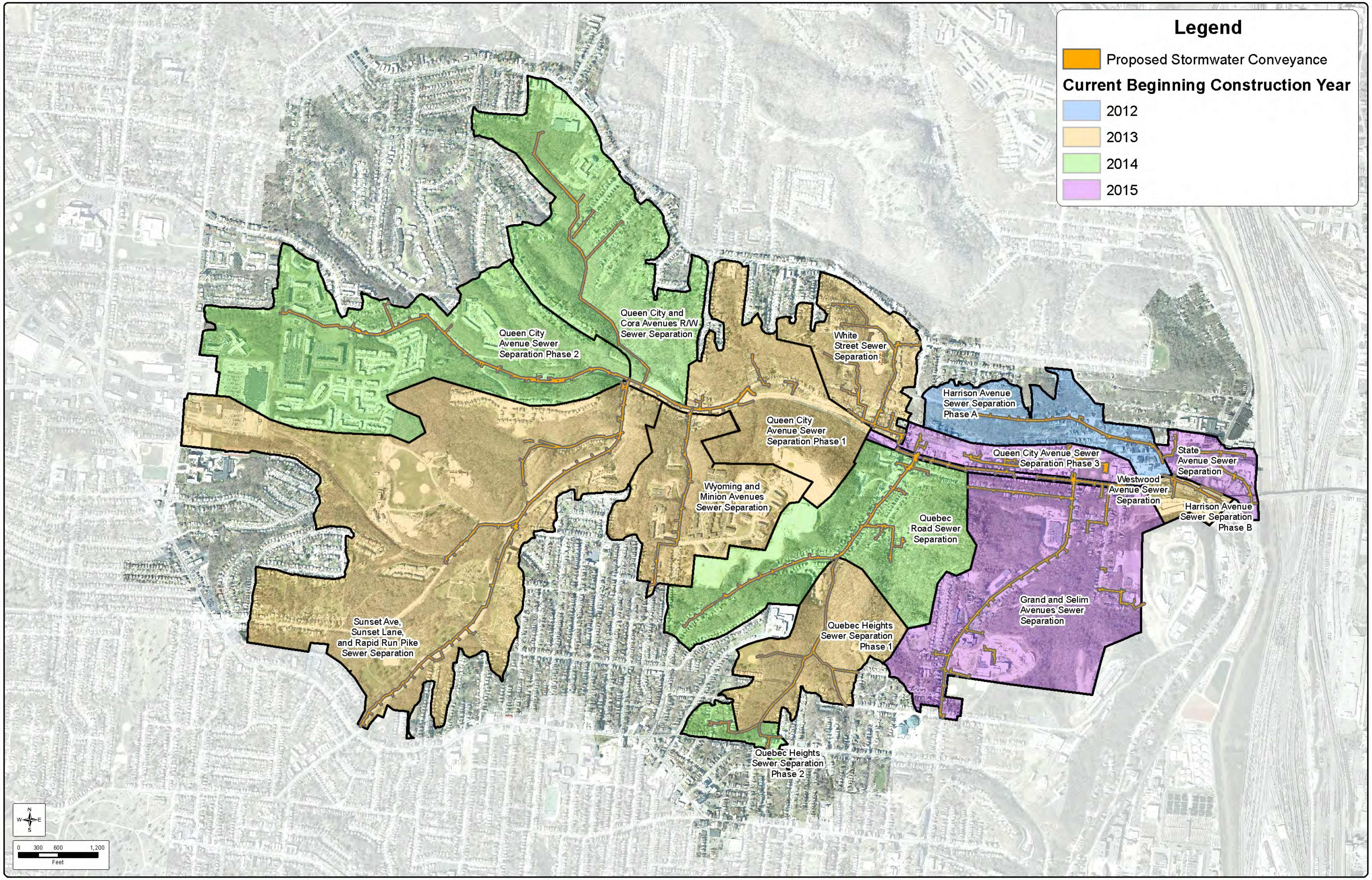

ESTIMATED CONSTRUCTION SCHEDULE FOR SEWER SEPARATION PROJECTS
LICK RUN WET WEATHER STRATEGY

METROPOLITAN SEWER DISTRICT OF GREATER CINCINNATI

STRAND ASSOCIATES, INC.® ENGINEERS

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In response to the above recommendation as well as others presented in the VE Study, MSDGC initiated the following three alternate solution evaluations:

A. Utilizing the existing CSS for stormwater conveyance and installing a new sanitary sewer system in the watershed. This evaluation includes sizing and costing a new sanitary sewer system as well as identifying existing combined sewers that would need to be modified to meet the Memorandum of Understanding (MOU) for transfer of assets from MSDGC to SMU. The combined sewers potentially not meeting the MOU were identified to be replaced or rehabilitated, and appropriate costs were assigned.

B. Sizing the proposed storm sewer system to be installed in the priority areas to allow for future full sewer separation. While construction of this would be a difficult and expensive undertaking, it has been suggested as a possibility in the future.

C. Sizing the proposed storm sewer system and urban VCS for the typical annual storm event, with sewer separation of the priority areas only.

Table 2.08-1 presents a coarse construction cost opinion for Alternate Solution A. The installation of a new sanitary sewer system must be accompanied by a conversion of the existing combined sewer system to a storm sewer system with appropriate rehabilitation measures before SMU will accept the system as a stormwater asset.

Component Description	Cost
Installation of New Sanitary Sewer	$ 83,100,000
Rehabilitation of Existing Combined Sewer because of Age or Condition	18,800,000
Replacement of Existing Combined Sewers because of Insufficient Capacity	42,300,000
TOTAL	**$ 144,200,000**

Table 2.08-1 Install New Sanitary Sewer System and Rehabilitate Existing Combined Sewer System

Table 2.08-2 presents a coarse construction cost opinion for Alternate Solution B. In addition to the increase in pipe and structure sizes to accommodate the runoff flows from the entire watershed and associated costs, consideration needs to be given to the infrastructure and associated costs needed to capture and convey the stormwater flows from the remainder of the watershed. To obtain these costs, a review of available data relating to sewer separation costs from other communities was performed. While available literature shows a wide variability in the range of separation costs, research on highly developed areas with land uses comparable to the non-priority areas indicated a value of $80,000 per acre to perform full separation appears to be a reasonable planning-level value. Based on this information, full separation of the non-priority areas would add an additional $72 million to the project costs. It should be noted that the October 2010 OPCC of $42 million was used as the baseline for this analysis and therefore, the $51.8 million presented in the table should not be compared to the current costs listed in Section 4. The cost to install proposed storm sewers sized for the entire watershed represents an increase of approximately $9.8 million over the cost to install proposed storm sewers sized for the priority areas only.

Component Description	Cost
Installation of New Storm Sewer System Sized for Future Full Separation	$ 51,800,000
Installation of Additional Storm Sewer to Capture and Convey Full Separation Flows	$ 72,000,000
TOTAL	**$123,800,000**

Table 2.08-2 Install New Storm Sewer System Sized for Future Full Separation

Table 2.08-3 presents a coarse construction cost opinion for Alternate Solution C. It should be noted that the October 2010 OPCC of $42 million was used as the baseline for analysis, and therefore, the $45.0 million presented in the table should not be compared to the current costs listed in Section 4. The cost to install proposed storm sewers sized to convey the typical annual event from the priority areas only actually represents a $3.0 million increase over the cost to install proposed storm sewers to convey the 10-year frequency storm event for the priority areas only. This is due to the diversion structures that would be required between the existing CSS and proposed storm system, which would allow conveyance of larger storm events.

Component Description	Cost
Installation of New Storm Sewer Sized for the Typical Annual Event	$ 45,000,000

Table 2.08-3 Install New Storm Sewer System Sized for the Typical Annual Event

Upon review of the results of this analysis, MSDGC has decided to proceed with strategic sewer separation using the methodology described previously.

The VE Study also presented the following general opportunities for enhancement in the strategic sewer separation project areas:

1. Optimize pipe sizes and locations.
2. Use open conveyances and detention.
3. Modify BMPs.
4. Optimize pipe layouts.
5. Review pipe jacking.
6. Modify drop manholes.
7. Explore more detention opportunities.
8. Expand sewer separation areas.

These opportunities are being evaluated on a project-by-project basis as they are advanced in design.

2.09 IMPLEMENTATION CONSIDERATIONS

The Wet Weather Strategy is a unique project and poses a number of challenges associated with its planning, design, construction, implementation, maintenance, and monitoring. Many of these challenges center around the priority and non-priority distinction.

A. Parcel Tracking

A clear delineation of the priority and non-priority areas will need to be developed that will include a parcel-by-parcel categorization that distinguishes the boundary between the priority and non-priority areas. All parcels within the watershed (both priority and non-priority areas) would maintain their sanitary/building connections to the existing combined sewer. The only change being proposed to existing conditions is that properties located within the priority area would have access to a storm sewer.

B. Trading and Credits

As the CSO control program is implemented, it would seem that the CSO credit program could be eliminated. The program would evolve into a sewer capacity connection program focused on dry weather capacity of the CSS. Any additional stormwater runoff to the CSS should be regulated as it is today.

C. New and Revitalization Runoff

Any changes to the existing stormwater runoff from a site in the priority area would be subject to the SMU regulations:

> "The peak rate of runoff from an area after development shall not exceed the peak rate of runoff from the same area before development for 2-, 10-, 25-, and 100-year frequency, 24-hour storm."

New and revitalization projects in the non-priority combined sewer areas would default to existing MSDGC rules and regulations for stormwater control. Specifically, Article III, Section 303 A states:

> "The volume of stormwater detained shall be the difference in runoff volume from the pre-developed site over a ten-year event of one hour duration and the post-developed site under a twenty-five year event of one hour duration. The peak rate of runoff from the site after development for a twenty-five year storm event of one hour duration shall not exceed the pre-development site peak runoff for a ten-year event of one hour duration."

The MSDGC and SMU requirements discussed above focus on peak discharge control. These regulations provide a mechanism for maintaining a relatively consistent level of service in terms of pipe capacity as new and revitalization occurs in the future.

D. CSS Regulations vs. MS4 Regulations

The State of Ohio's Municipal Separate Storm Sewer System (MS4) permit requires all new and revitalization projects disturbing more than one acre of land and discharging to an MS4 to implement controls to manage the runoff from a 0.75-inch rain event. As revitalization occurs in the separate system (priority areas), these regulations should help to reduce runoff volumes entering the storm sewer system. Even with the focus on smaller storms, this requirement should have cumulative benefits. In fact, MSDGC should consider requiring similar postconstruction controls for new and revitalization projects in the CSS in an effort to reduce CSOs and provide additional wet weather capacity in the system at no additional cost to MSDGC.

Other significant challenges unrelated to the priority and non-priority boundary should also be expected such as ownership and maintenance, easement acquisition, maintenance of traffic, and aggressive project schedules.

SECTION 3
URBAN VALLEY CONVEYANCE SYSTEM

3.01 INTRODUCTION

As indicated in the previous sections, the foundation of the Wet Weather Strategy consists of two primary elements, strategic sewer separation and an urban valley conveyance system (VCS). The VCS will receive the stormwater runoff captured and conveyed from the strategic sewer separation areas, as well as overland flow that is expected to occur during large storm events, and will ultimately discharge these flows to the Mill Creek.

This section discusses the urban VCS component of the Wet Weather Strategy including background, modeling, design criteria, design elements, benefits, schedule, value engineering, and potential challenges. Costs are discussed separately in Section 4.

3.02 BACKGROUND

A. Purpose

As described in Section 2, MSDGC submitted its WWIP on June 4, 2009, and a major focus of the WWIP Phase 1 is the reduction of approximately 2 billion gallons annually from CSOs discharging to the Mill Creek by the end of 2018. Because CSO 005 in the Lick Run Watershed discharges the greatest CSO volume in the Lower Mill Creek Watershed on an annual basis, a desired goal of reducing CSOs by 800 million gallons annually was established for the Lick Run Watershed to help achieve the 2-billion-gallon reduction.

B. Project Development

As the sustainable watershed evaluation process (SWEP) was applied to the Lick Run Watershed, it became clear that several unique, defining characteristics would significantly influence the Wet Weather Strategy. As previously mentioned, the inventory of existing data revealed a number of direct entry points where systems of creeks and streams, and stormwater runoff from large forested hillsides, directly enter the CSS creating a significant opportunity to remove substantial amounts of stormwater from the CSS. Currently, runoff from the watershed drains to a large diameter combined sewer that ranges in size from 14.5 to 19.5 feet in diameter. This large diameter combined sewer runs the length of the corridor and connects to the Mill Creek Interceptor that ultimately conveys flows to the Mill Creek Wastewater Treatment Plant or discharges to the Mill Creek via CSO 005.

While strategic separation (as discussed in Section 2) represented the means to capture this runoff, the challenge of how to convey this flow to the Mill Creek led to the concept of an urban VCS, located in the watershed's central corridor between Queen City Avenue and Westwood Avenue. A review of historical records indicates this area is the approximate location of the original Lick Run channel.

While MSDGC recognized the functional and aesthetic characteristics of the urban VCS require significant public input, MSDGC decided the technical feasibility should be examined and verified before initiating an extensive stakeholder input process. During the initial phases of the project, several conveyance alternatives were evaluated to confirm the technical feasibility of the urban VCS. Of the alternatives evaluated, MSDGC felt a hybrid system consisting of an open channel above a subsurface box conduit would achieve the required level of CSO control while embracing MSDGC's *Communities of the Future* initiative. The open channel system above a subsurface box conduit option, referred to as the hybrid VCS, is currently in the conceptual design phase as MSDGC progresses with the public involvement process and develops a Master Plan. Section 5 of this report provides an overview of the public engagement effort that will help guide the development of a Master Plan for the VCS and central corridor area. The remainder of this section will focus on the modeling and technical aspects of the conceptual hybrid VCS. It should be emphasized the information presented is conceptual in nature and will likely evolve in response to public engagement and stakeholder input as the Master Plan is developed and the project progresses into design.

C. Hybrid Valley Conveyance System

In addition to CSO control and MSDGC's *Communities of the Future* initiative, several factors were considered in the development of this hybrid VCS concept as a preferred alternative including flow moderation, habitat enhancement, pollution control benefits, open space and water features, operation and maintenance, geotechnical considerations, and key properties located within the central corridor.

The hybrid option provides a number of advantages as listed below:

1. Enhanced habitat quality.
2. High velocity conveyance conditions confined to the underlying box conduit except for relatively infrequent events.
3. Additional land area available for other community amenities such as parks and open space.
4. Additional land area available for revitalization opportunities providing a catalyst for economic development and an asset for the community.

The disadvantages of the hybrid option include the following:

1. Routine maintenance will be required as debris and sediment will likely accumulate in the open channel.
2. Accommodations will need to be made for maintenance of the box conduit.
3. Routine conventional landscape maintenance will be required for any open space areas adjacent to the channel.

While the primary element of the hybrid VCS is the open channel above the subsurface box conduit, this conceptual arrangement also includes several other elements including best management practices. Before initiating a public engagement and master planning process, the hybrid VCS option consists of the following elements:

1. Hybrid Conveyance System

   a. Outfall to Mill Creek.

b. Hybrid open channel and box conduit (approximately 5,700 linear feet).
   (1) Low flow channel.
   (2) Subsurface box conduit (varies in size from a 5-foot by 20-foot to a 5-foot by 33-foot box)
   (3) Hydraulic interconnections between the low flow channel and box conduit.
c. Five road crossing structures and one railroad crossing structure.
d. Closed 6-foot by 10-foot box conduit (approximately 2,400 linear feet).

2. Best Management Practices
   a. Five structural separators.
   b. Regional online stormwater pond.
   c. Open water forebay at upstream end of the channel to receive first flush flows.

Figure 3.02-1 illustrates the hybrid VCS. Detailed information relating to the modeling and design of the aforementioned elements of the hybrid VCS concept are included in the following sections.

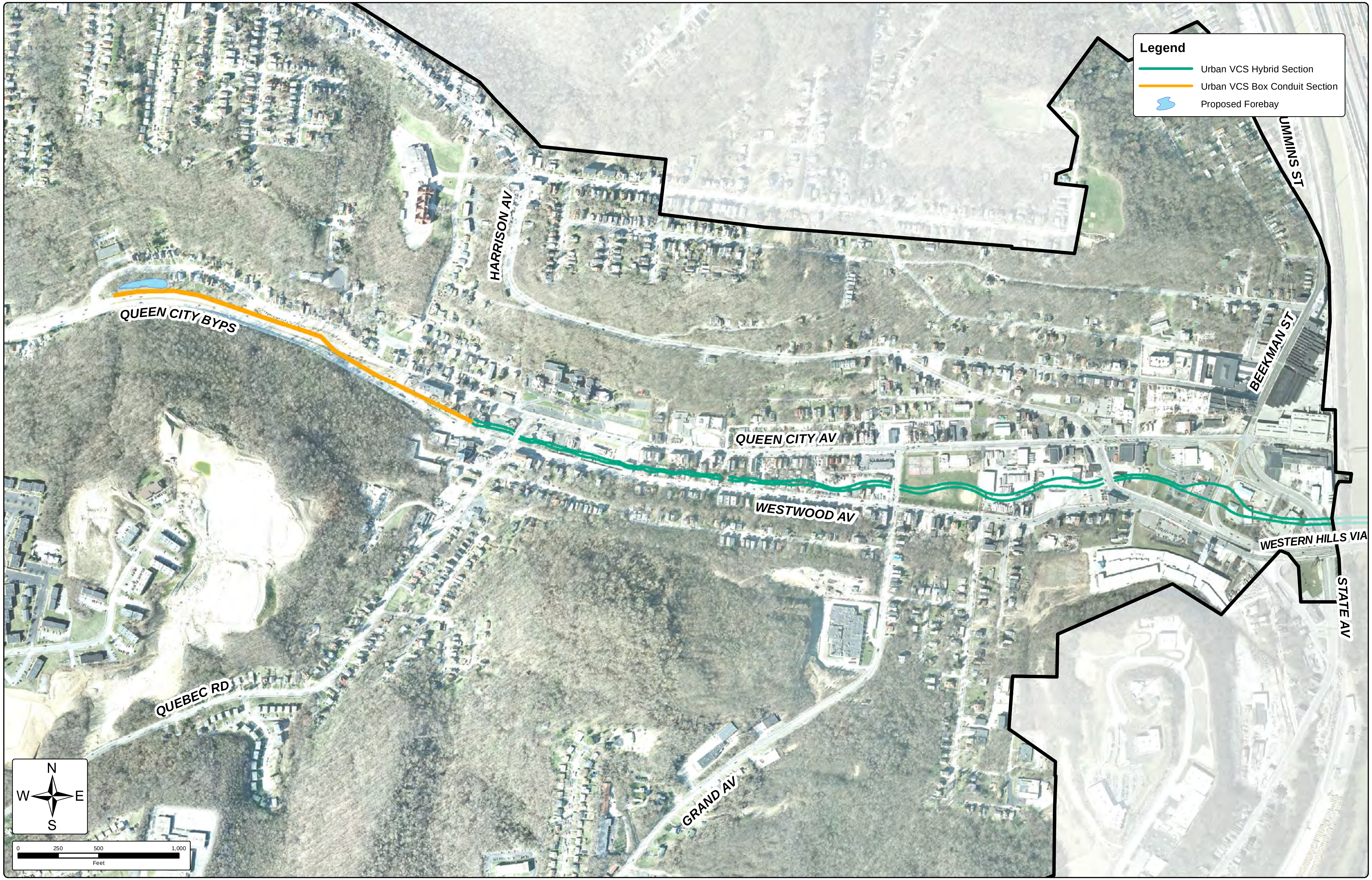
3.03 MODELING

The development of engineering models to analyze and refine the preliminarily design for the proposed hybrid VCS has evolved through several phases. The following section presents the most recent modeling results, and previous efforts can be referenced in the reports included in Appendix A. The following section also presents anticipated water quality benefits of best management practices included in the conceptual hybrid VCS alternative.

A. <u>Hybrid Valley Conveyance System–Hydrologic and Hydraulic Modeling</u>

A HEC-HMS hydrologic model has been created to develop runoff hydrographs entering the VCS. HEC-HMS is a computer program developed by the United States Army Corps of Engineers that simulates the precipitation-runoff process. HEC-HMS estimates peak stormwater discharges and volumes based on mathematical input parameters representing precipitation depth and time distribution, drainage area, land use, and time of concentration for each subbasin. Further discussion regarding hydrologic modeling methodologies, input parameters, and assumptions is included in the November 2009 *Lick Run Preliminary Engineering Analysis* report.

While it is understood the existing combined sewers in the non-priority areas currently intercept convenience drainage runoff, stormwater flows that exceed the capacity of these upstream combined sewers likely flow via overland flood routes and either enter the main Lick Run combined sewer interceptor at points farther downstream or overflow directly into Mill Creek. Because strategic sewer separation is now being proposed for the priority areas, and the relative capacity of the existing combined sewer system in the non-priority areas to accommodate the convenience drainage flows is uncertain, it was conservatively assumed that none of the runoff during the 100-year design storm was collected in the existing combined system and would ultimately need to be conveyed by the VCS.



URBAN VALLEY CONVEYANCE SYSTEM
LICK RUN WET WEATHER STRATEGY

COMPREHENSIVE DESIGN REPORT
METROPOLITAN SEWER DISTRICT OF
GREATER CINCINNATI

STRAND ASSOCIATES, INC.® ENGINEERS

FIGURE 3.02-1
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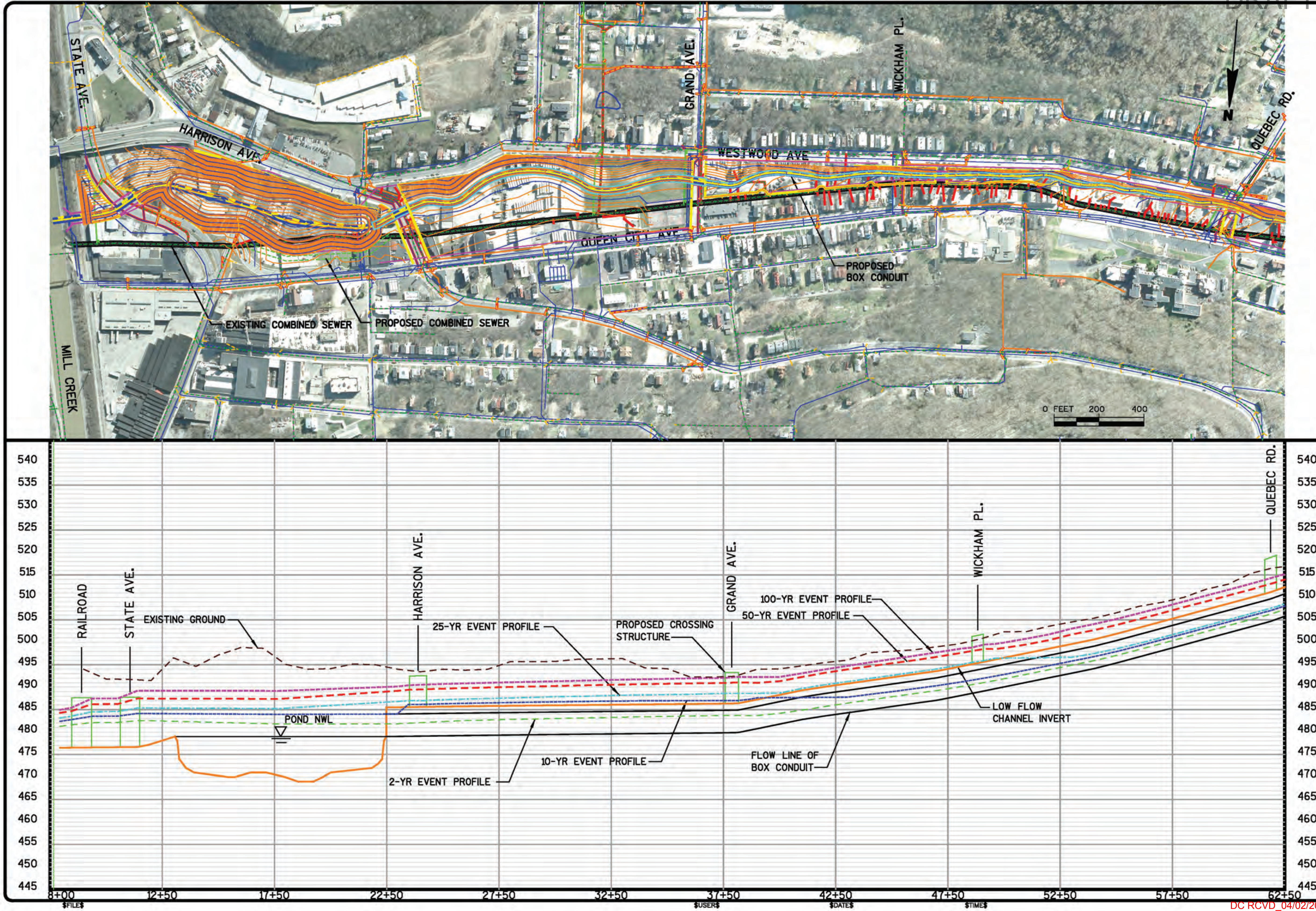
Runoff hydrographs for various return interval storm events were developed, for both the entire watershed and the strategic sewer separation areas, and imported into the xpswmm computer program. Because of the unique character of the conceptual hybrid VCS and the hydraulic interconnection of the open channel and subsurface box conduit, the Extended Transport (EXTRAN) module of xpswmm was used to calculate the hydraulic capacity of this system. EXTRAN is a dynamic flow routing model that routes runoff hydrographs through an open channel and/or closed conduit system computing the time history of peak runoff flows, hydraulic grade line elevations, and velocities throughout the system. Inputs to EXTRAN included the following:

1. The physical geometry of the box conduit conveyance system including culvert sizes and shapes, invert elevations, roughness coefficients, and special hydraulic structures including grates providing connections to the open channel system.

2. The physical geometry of the open channel conveyance system including channel geometry and invert elevations, online detention basin elevations and storage volume, roadway and railroad crossing structure geometry, ground elevations, and roughness coefficients.

3. Starting tailwater conditions at Mill Creek. Flood elevations from the Hamilton County Flood Insurance Study (FIS) were used for starting conditions for each corresponding return interval event analyzed [i.e., the Mill Creek 100-year FIS flood elevation 484 (NGVD)].

The hydraulic model results indicated the VCS can be constructed within the project constraints (specifically, between Westwood Avenue and Queen City Avenue, avoiding the existing large diameter combined sewer interceptor) and a minimum 1-foot freeboard can be provided in all areas between the estimated 100-year design flow elevation and adjacent street areas. Based on the results of the xpswmm evaluation, the hydraulic performance of the Lick Run VCS design will convey the peak runoff for storm events up to and including a 100-year statistical recurrence interval. Estimated 2-,10-, 25-, 50-, and 100-year water surface flood profiles are depicted in Figure 3.03-1 and a 100-year event inundation map is included as Figure 3.03-2.



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LICK RUN CHANNEL PLAN & PROFILE

BASIS OF DESIGN REPORT
LICK RUN WET WEATHER STRATEGY
METROPOLITAN SEWER DISTRICT OF GREATER CINCINNATI

STRAND ASSOCIATES, INC.® ENGINEERS

SHEET
Figure 3.03-1
JOB NO.

FIGURE 3.03-2–ESTIMATED 100-YEAR EVENT INUNDATION MAP

Table 3.03-1 is a crossing structure summary for the 100-year event for roadways running north-south between Queen City and Westwood Avenue. Reference Tables 5.02-2 through 5.02-6 (pages 5-4 through 5-13) of the *Lick Run Hybrid Conveyance System Evaluation* Report, included in Appendix A, for the 2-, 10-, 25-, 50-, and 100-year storm frequency hydraulic modeling results from the xpswmm model.

Structure Location	Conceptual Structure Size and Type	Approximate Top of Road/Railroad Elevation (feet)	100-Year Headwater Elevation (feet)	Freeboard (feet)
CH & D RR	58-foot precast arch bridge	495	487.5	7.5
State Avenue	58-foot precast arch bridge	490	489.2	0.8
Harrison Avenue	36-foot precast arch bridge	493	490.6	2.4
Grand Avenue	36-foot precast arch bridge	494	492.3	1.7
Wickham Place	34-foot precast arch bridge	501	499.5	1.5
Quebec Road	30-foot precast arch bridge	516.4	515.1	1.3

Table 3.03-1 Lick Run Valley Conveyance System–Crossing Structure Summary

B. Hybrid VCS–Hydraulic Connectivity Modeling

The open channel and subsurface box conduit system will be hydraulically connected via inlet grates at four locations along the length of the system to allow the two conveyance facilities to function as an integrated, single hydraulic entity. The inclusion of these hydraulic connections allows excess flows in the open channel to enter the box conduit system and maximize available hydraulic capacity and vice versa. When the hydraulic capacity of the box conduit system is exceeded, excess stormwater will surcharge through the inlet grates into the open channel system. This hydraulic connectivity provides the capacity required to convey the peak runoff discharge for a 100-year storm event.

Additional detail relating to the locations of these connections and preliminary design is included in Section 3.05B.

Table 3.03-2 summarizes the maximum flows that enter into and surcharge from the box conduit system to the open channel system for a 2-, 10-, 25-, 50-, and 100-year storm event. Because of the dynamic nature in which the hybrid VCS will operate, peak stormwater flows will both flow in to and out of the inlet grates at Quebec Road, Wickham Place, and Grand Avenue. The inlet grate located at the headwaters of the hybrid VCS will only take flow into the system.

Headwater Grate		
Storm Return Interval (Years)	Maximum Grate Inflow (CFS)	Maximum Grate Outflow (CFS)
2	0	0
10	0	0
25	0	0
50	464	0
100	768	0

Quebec Road Grate		
Storm Return Interval (Years)	Maximum Grate Inflow (CFS)	Maximum Grate Outflow (CFS)
2	0	0
10	0	0
25	0	0
50	349	0
100	510	130

Wickham Place Grate		
Storm Return Interval (Years)	Maximum Grate Inflow (CFS)	Maximum Grate Outflow (CFS)
2	0	0
10	0	0
25	0	0
50	88	460
100	113	529

Grand Avenue Grate		
Storm Return Interval (Years)	Maximum Grate Inflow (CFS)	Maximum Grate Outflow (CFS)
2	7	0
10	22	0
25	32	122
50	230	216
100	238	334

Table 3.03-2 Inlet Grate Modeling Results

C. Hybrid VCS–Storm Sewer Connection Modeling

The majority of the stormwater being conveyed by the proposed storm sewers described in Section 2 will discharge directly into the subsurface box conduit, while overland flows draining to the central corridor are anticipated to drain directly to the VCS. This arrangement of stormwater discharge will reduce the frequency that excessive stormwater depths and velocities are experienced in the open channel portion of the hybrid VCS, thereby allowing for a more consistent and aesthetically pleasing community amenity. There are currently a total of ten direct connections from the proposed storm sewers to the subsurface box conduit. Additional detail relating to the locations of these connections and preliminary design options are included in Section 3.05C. Table 3.03-3 lists the proposed connections and associated flows (in cubic feet per second) for various storm events.

Connection Location	Storm Event					
	3/4-inch	***2-year***	***10-year***	***25-year***	***50-year***	***100-year***
Headwater	108	418	758	986	1717	2138
Clifford Street	2	6	9	11	16	19
Quebec Road	21	109	243	348	653	838
Wickham Place	5	15	26	32	46	54
Grand Avenue	46	166	308	403	454	548
Queen City Avenue	9	32	58	75	99	111
Harrison Avenue (north)	9	34	64	84	118	141
Harrison Avenue (south)	8	18	28	35	61	73
State Avenue (north)	7	16	26	32	38	44
State Avenue (south)	3	8	12	15	18	21

Table 3.03-3 Flows at Proposed Storm Sewer Connections

D. Best Management Practices–Water Quality Modeling

Water quality modeling of stormwater BMPs provides a quantitative comparative analysis of various applications. Current modeling techniques are evolving to account for an ever expanding array of best management practices applications. As advanced as this modeling has become, numerous best management practices applications remain with intuitive qualitative and unsubstantiated quantitative performance characteristics.

A water quality modeling and alternatives analysis was completed for the Lick Run Watershed to estimate pollutant loads resulting from stormwater runoff and to provide recommendations for water quality improvements. Pollutants addressed in this analysis include total phosphorus, total nitrogen, total suspended solids, and bacteria, and ultimately the analysis determined that implementation of nine detention basins, green infrastructure technologies constructed as ESPs, and structural separators installed immediately upstream of all connections to the VCS would provide adequate water quality benefits for the Wet Weather Strategy. Details relating to the best management practices applications included in the VCS design elements are presented in Section 3.05 of this report.

An initial assessment of water quality implications associated with the Wet Weather Strategy was completed using the "Source Loading and Management Model" (WinSLAMM V.9.4) for proposed best management practices. WinSLAMM is a computer model that analyzes nonpoint source pollution abatement and has been calibrated using extensive water quality data throughout the United States. WinSLAMM analyzes control practices including street sweeping, wet detention ponds, catch basins and inlet sumps, infiltration devices, porous pavements, and grass swales. The program also estimates relative pollutant contributions from source areas including rooftops, parking lots, driveways, streets, sidewalks, and pervious space. Input data for this model included land use characteristics of the priority drainage areas. Table 3.03-4 provides the results of the WinSLAMM model assuming no best management practices are in place (baseline conditions) and assuming the proposed open water forebay near Queen City Bypass and the proposed online wet detention basin located immediately downstream of Harrison Avenue and upstream of State Avenue are constructed and operational.

	Particulate Solids		
Annual Loading	**Yield (lbs)**	**Reduction (%)**	**Concentration (mg/L)**
Baseline Conditions	569,758	0%	147.8
After Implementation of QC Bypass Forebay and Online Wet Basin Downstream of Harrison Avenue	250,883	56%	65.1

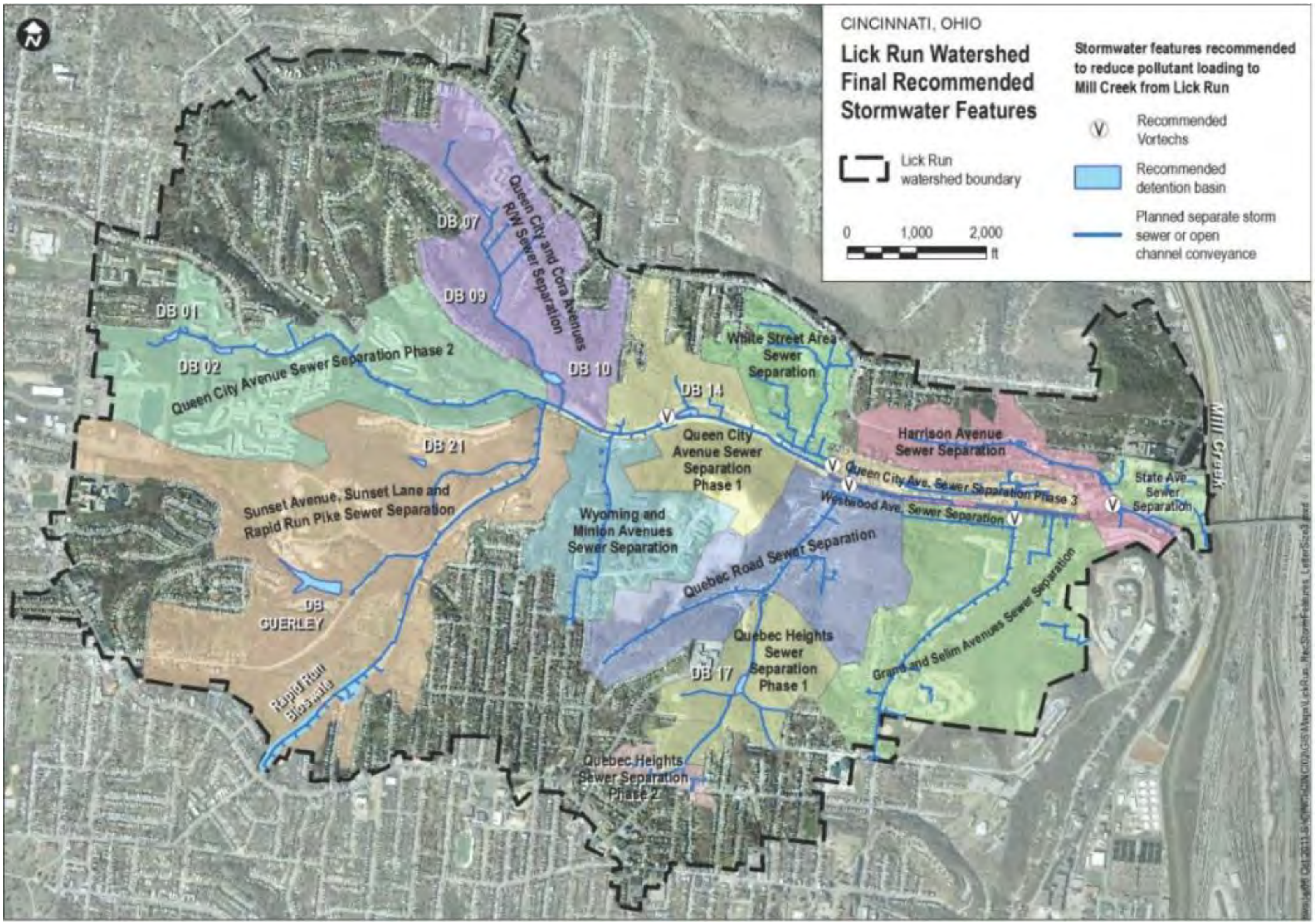
Table 3.03-4 Annual TSS Loading in Valley Conveyance System

Additional water quality evaluations on the proposed detention basins and structural separators proposed to be included in the Wet Weather Strategy were performed using the USEPA Storm Water Management Model (SWMM) (previously developed for Lick Run CSS modeling) and the design point method developed by the Center for Watershed Protection. As previously mentioned in Section 2, the results of this evaluation revealed nine detention basins (seven within the sewer separation projects, the Guerley Road detention basin being independently constructed by SMU, and one water quality forebay included as a design element of the VCS), green infrastructure technologies constructed as ESPs (in particular the Rapid Run ESP), and structural separators installed in strategic locations immediately upstream of the VCS will provide significant water quality benefit and, therefore, should be advanced in design. As designs of the sewer separation areas and VCS progress, additional water quality modeling will likely be completed and the current configuration or location of best management practices may change. In particular, the exact location of the stormwater separators will be determined once the VCS is advanced in design. The recommended best management practices that have been modeled are shown in Figure 3.03-3 and their associated estimated pollutant load reductions are presented in Table 3.03-5. The figure and the values in the table were obtained from the Lick Run Watershed Phase 2 Stormwater Modeling and Assessment Final Report, included in Appendix A.

Stormwater Control Project	Annual Estimated TP Load Reduction (kg)	Annual Estimated TN Load Reduction (kg)	Annual Estimated TSS Load Reduction (kg)	Annual Estimated Bacteria Load Reduction (lbs)
DB 01	11	20	4,145	19,000,000
DB 02	14	26	3,676	27,000,000
DB 07	27	51	10,175	47,000,000
DB 09	37	72	14,504	6,200,000
DB 10	48	96	15,753	93,000,000
DB 14 (forebay)	396	688	148,332	520,000,000
DB 17	17	45	10,611	25,000,000
DB 21	7	14	3,971	720,000
DB Guerley	104	180	30,237	210,000,000
Rapid Run ESP	52	79	8,790	34,000,000
TOTAL	**713**	**1271**	**250,194**	**980,000,000**

Table 3.03-5 Estimated Pollutant Load Reductions

FIGURE 3.03-3–WATER QUALITY FEATURES



3.04 DESIGN CRITERIA

In general, storm sewer system designs of this magnitude, and in particular, a hybrid open channel and box conduit VCS design, are not common projects for MSDGC. Therefore, the design of the hybrid VCS will require coordination among the project team, MSDGC, and SMU as design criteria are established and the design is advanced. Although the hybrid VCS option is currently at the conceptual level of design and many design criterion have not been fully established, several key elements have served as guidance for the preliminary evaluation of this system and have influenced the development of the conceptual design.

A. Channel Geometry and Sizing

The SMU Rules and Regulations provide guidelines on open channel configurations and sizing requirements. Generally, the rules state:

> "Open channels are usually designed with sections of regular geometric shapes. The trapezoid is the most common shape… the rectangle and triangle are special cases of the trapezoid…"

> "Roadside ditches shall be designed for the 10-year storm. All other open channels, except major channels as defined herein, shall be designed for the 25-year storm. Major channels shall be designed for the 100-year storm. Major channels are the following streams: Ohio River, Little Miami River, Mill Creek…."

While SMU does not specify a particular geometric configuration or detailed design considerations for conveyance systems such as the conceptual hybrid VCS, it expects the design to have capacity to avoid flood damage and excessive velocities. Therefore, the hybrid VCS system was conservatively designed to convey the 100-year flood flow from the entire Lick Run Watershed. This conservative design also provides flood protection for potential revitalization in the central corridor.

B. Geotechnical Considerations

The preliminary geotechnical exploration, presented in Section 2 and included in Appendix A, resulted in several geotechnical recommendations in the central corridor, particularly relating to the excavation associated with construction of the VCS.

The following items provide a summary of the central corridor observations and recommendations presented in the report:

1. Primarily fill soils with some excavation into underlying lakebed soils, sediment, or colluvium.
2. Perched groundwater will be encountered.
3. Permanent side slopes should not exceed 4H:1V.
4. Temporary shoring of structures, roadways, and temporary cut slopes.
5. Scour protection of permanent slopes.
6. Permanent retaining walls and bridge/culvert structures at roadway crossings.
7. Disposal of large cut volumes.

These recommendations and other information included in the Geotechnical Exploration Report were considered in the development of the conceptual hybrid VCS design.

3.05 DESIGN ELEMENTS

A. Hybrid Conveyance System

The hybrid VCS is located between Queen City Avenue and Westwood Avenue and extends approximately 8,100 feet from the Mill Creek to the open water forebay located on the western end of Queen City Avenue near the bypass. Starting downstream at the confluence with Mill Creek, the hybrid VCS option includes approximately approximately 5,700 linear feet of the hybrid open channel and box conduit system, approximately 2,400 linear feet of subsurface box conduit, and an open water forebay at the upstream end. The regional online stormwater pond and open water forebay are considered best management practices and, therefore, are addressed separately from the conveyance elements.

The hybrid open channel and box conduit system includes a low flow channel (varying in width from 12 feet to 15 feet), a subsurface box conduit (varying in size from 5 feet by 20 feet to 5 feet by 33 feet), and a shallow excess flow region (incorporating a surface area up to 300 feet wide). This system is unique in that the box conduit and open channel are hydraulically connected and ten of the proposed storm sewers connect directly into the system within this portion of the VCS option.

An illustration of a typical cross section for this element of the hybrid VCS, looking upstream from Grand Avenue, is shown below in Figure 3.05-1.

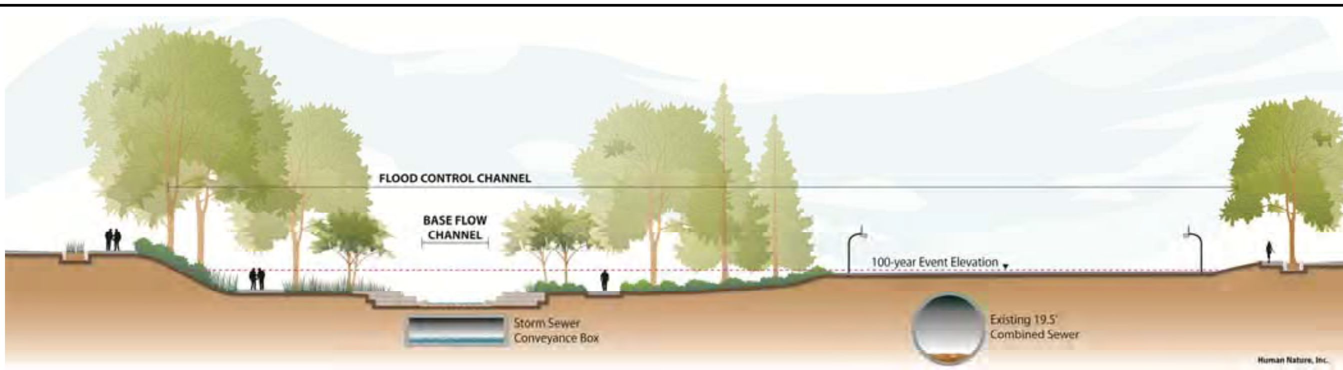


Figure 3.05-1 Hybrid Option Typical Cross Section

A 6-foot by 10-foot box conduit is proposed upstream of the hybrid open channel and box conduit system between the headwaters of the hybrid system at the eastern end of White Street and the open water forebay at the western end of Queen City Avenue. This configuration was proposed in this location because of the corridor constraints of Queen City Avenue and Queen City Bypass and the existing large diameter combined sewer.

In addition to CSO control and MSDGC's *Communities of the Future* initiative, several factors were considered in the development of this hybrid VCS concept as a preferred alternative including flow moderation, habitat enhancement and pollution control benefits, open space and water features, and operation and maintenance.

1. Flow moderation

This option provides a reasonable balance in safeguarding the public's exposure to relatively high velocity stormwater conveyance conditions. Except for relatively infrequent events, high velocity conveyance conditions will be confined to the underlying box conduit. During extreme rain events where high velocity conveyance conditions could develop in the low flow and excess flow regions of this option, it is anticipated that weather conditions would discourage public exposure to these occurrences.

2. Habitat Enhancement and Pollution Control

Pollutant control will be enhanced mostly by the diversion of excessive urban runoff to the box conduit and out of the stream channel. However, the greatest benefit of the box conduit system will be enhancing the capacity of the open channel to assimilate the urban stormwater runoff into a more natural environment. This alternative provides good opportunities for achieving pollution control and improved habitat quality, provided the appropriate design elements can be implemented.

3. Open Space and Water Features

The hybrid VCS option will allow additional open space for landscaped areas, water features, and potential for revitalization. These areas will provide an asset to the community by contributing to the aesthetic quality of the corridor. In addition to providing increased opportunities for high quality open space areas and water features, this hybrid option allows increased opportunities for potential revitalization of currently underutilized land areas within this immediate corridor and adjacent neighborhoods. It is anticipated the enhanced and controlled aesthetics of the channel area combined with renewed opened space areas will provide a catalytic effect for these potential revitalization initiatives.

4. Operation and Maintenance

Ideally, an open channel should be as self-maintaining as is feasible. However, given the constraints of the urban setting, some maintenance will be required in order to maintain a pleasing visual appearance consistent with a community amenity. Proposed structural separators, discussed in more detail later in this section, will help to remove portions of heavier sediment and floatables, but these structures will require periodic maintenance themselves to be effective.

B. Hydraulic Connectivity Between Open Channel And Box Conduit

As previously mentioned in the modeling section, the box conduit and open channel section will be hydraulically connected at four locations to allow the two conveyance facilities to function as an integrated, single hydraulic entity. Each of the four hydraulic connection locations are shown in Figure 3.05-2.

C. Proposed Storm Sewer Connections to Hybrid VCS

As previously mentioned in the modeling section, the proposed sewer separation alignments will be directly connected to the hybrid VCS. This arrangement of stormwater discharge will reduce the frequency that excessive stormwater depths and velocities are experienced in the open channel portion of the hybrid VCS, thereby allowing for a more consistent and aesthetically pleasing community amenity. The locations of these ten connections are illustrated in Figure 3.05-3.

FIGURE 3.05-2–INLET CONNECTION LOCATIONS

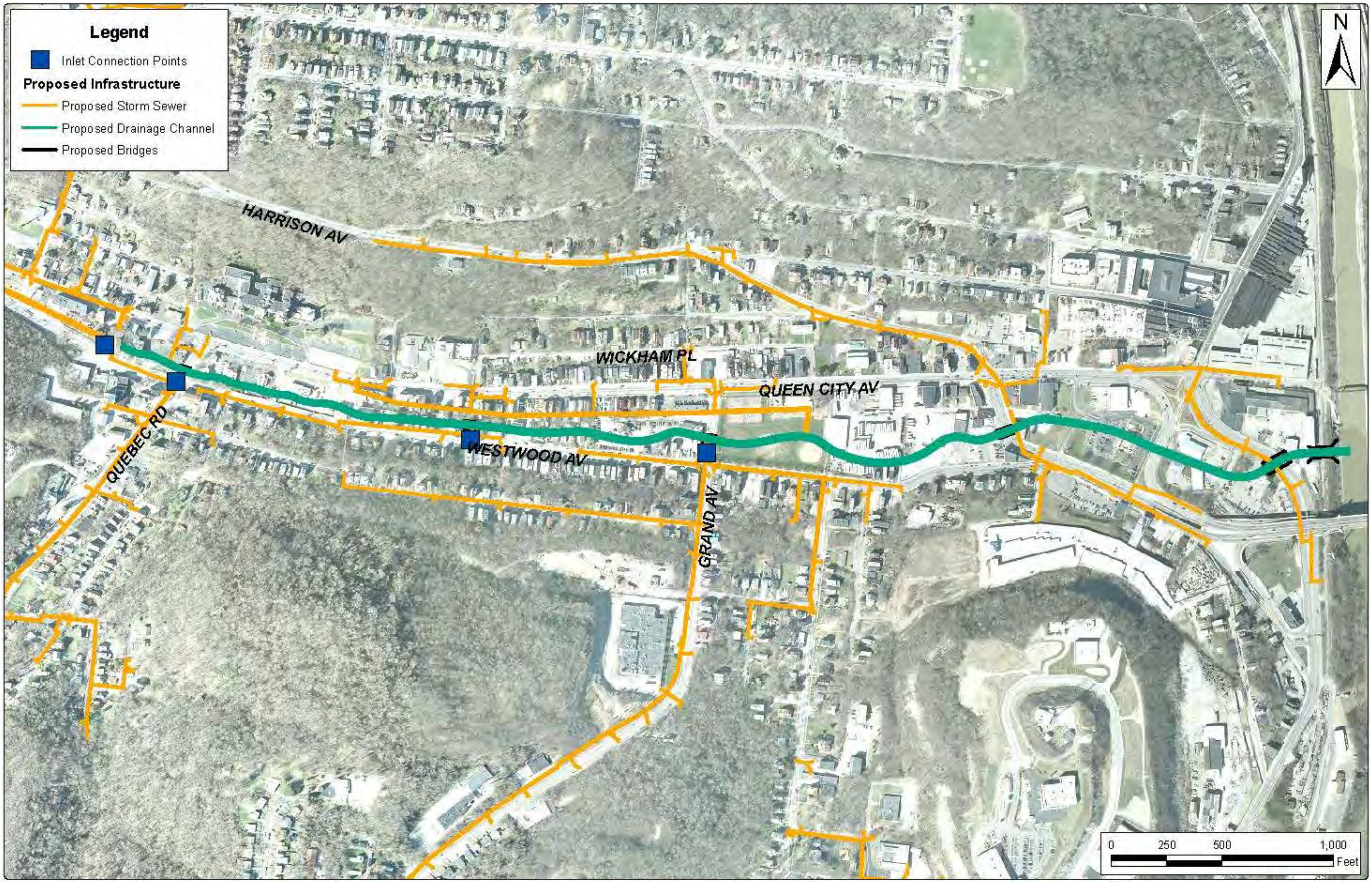


FIGURE 3.05-3–CONNECTIONS TO THE HYBRID SYSTEM

Sources for the desired base flow include groundwater harvesting and surface water harvesting. The quantity of groundwater that could be harvested is dependent on a number of variables, including location of the rock/soil interface, permeability of bearing soils above this interface, head differential, and hydraulic connectivity. At this conceptual stage there is insufficient information available regarding the characteristics of the rock/soil interface and the water bearing soils to make precise estimates of the potential groundwater yield. However, from the geotechnical characteristics provided in the soil borings to date, it is possible to speculate as to what these yields could be under assumed conditions.

In addition to the known areas of high groundwater, it is anticipated that with the construction of approximately 15 miles of new storm sewers throughout the Lick Run Watershed, there will be an opportunity to intercept yet unidentified groundwater sources along the proposed alignments. While it is not possible to accurately account for this potential source, it seems there is reasonable potential to harvest some of this groundwater through joint and structure infiltration. In an effort to develop an estimate of the potential volume of infiltration that could be realized from this source, minimum infiltration standards for sewer pipe as established by Ten State Standards were assumed as follows:

1. Soils that were identified in the areas of elevated groundwater included clay/silty clay, and the permeability for this classification of soil is typically between 0.06 and 0.20 inches per hour.

2. The allowable infiltration into a new sewer pipe according to the Ten State Standards is 200 gallons per day per inch-diameter per mile of pipe.

The results are shown in Table 3.05-1.

Proposed Sewer Separation Project	Pipe	Granular	Groundwater
Queen City Avenue Phase 1	2,200	200	80
Sunset Avenue, Sunset Lane and Rapid Run Pike	800	190	30
Queen City Avenue Phase 1	540	80	10
Queen City Avenue Phase 2	300	50	5
Quebec Road	300	50	5
Sunset Avenue, Sunset Lane and Rapid Run Pike	300	50	5
Overall Storm Sewer System	N/A	N/A	50
		TOTAL	**185 gpm**

Table 3.05-1 Estimated Groundwater Harvesting Yield

A number of surface water harvesting locations were identified and a visual inspection was performed at each location. The visual inspection allowed an estimated flow rate to be determined. The results are shown in Table 3.05-2.

Sources for the desired base flow include groundwater harvesting and surface water harvesting. The quantity of groundwater that could be harvested is dependent on a number of variables, including location of the rock/soil interface, permeability of bearing soils above this interface, head differential, and hydraulic connectivity. At this conceptual stage there is insufficient information available regarding the characteristics of the rock/soil interface and the water bearing soils to make precise estimates of the potential groundwater yield. However, from the geotechnical characteristics provided in the soil borings to date, it is possible to speculate as to what these yields could be under assumed conditions.

In addition to the known areas of high groundwater, it is anticipated that with the construction of approximately 15 miles of new storm sewers throughout the Lick Run Watershed, there will be an opportunity to intercept yet unidentified groundwater sources along the proposed alignments. While it is not possible to accurately account for this potential source, it seems there is reasonable potential to harvest some of this groundwater through joint and structure infiltration. In an effort to develop an estimate of the potential volume of infiltration that could be realized from this source, minimum infiltration standards for sewer pipe as established by Ten State Standards were assumed as follows:

1. Soils that were identified in the areas of elevated groundwater included clay/silty clay, and the permeability for this classification of soil is typically between 0.06 and 0.20 inches per hour.

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The results are shown in Table 3.05-1.

Proposed Sewer Separation Project	Pipe	Granular	Groundwater
Queen City Avenue Phase 1	2,200	200	80
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Queen City Avenue Phase 1	540	80	10
Queen City Avenue Phase 2	300	50	5
Quebec Road	300	50	5
Sunset Avenue, Sunset Lane and Rapid Run Pike	300	50	5
Overall Storm Sewer System	N/A	N/A	50
		TOTAL	**185 gpm**

Table 3.05-1 Estimated Groundwater Harvesting Yield

A number of surface water harvesting locations were identified and a visual inspection was performed at each location. The visual inspection allowed an estimated flow rate to be determined. The results are shown in Table 3.05-2.

Location	Surface
Guerley Road and Dunham Way (Sunset Avenue, Sunset Lane, and Rapid Run Pike;	5
Lane Avenue (Grand and Selim Avenues; near L-8)	10
Queen City Avenue and Bluffcrest Lane (Queen City Ave. Phase 2; near KA-7)	5
Queen City Bypass and Queen City Avenue (Queen City Avenue Phase 1; near QC-1)	5
Queen City Avenue and Ridge Top (Queen City Avenue Phase 2; near KA-08)	10
Lehman Road and Radcliff Drive (Grand and Selim Avenues; upstream of G-85)	5
TOTAL	**40**

Table 3.05-2 Observed Surface Water Harvesting Yield

Based on the anticipated yields, harvested sources may only account for approximately 15 percent of the total desired base flow in the open channel. As a result, it would appear reasonable to expect recirculated pond water from the regional online stormwater pond will be necessary to supplement the harvested groundwater and surface water. Given the uncertainty regarding the seasonal reliability and yield of the groundwater and surface water sources, it would appear prudent for the recirculation system to be capable of supplying the entire minimum desired base flow of 1,500 gpm. With expected pump operating conditions of approximately 1,500 gpm at 60 feet of total dynamic head, it is anticipated that a single 40-horsepower submersible pump would be required.

E. Best Management Practices–Structural separators

Structural separators will be placed at strategic locations within the proposed storm sewer system, particularly in locations where significant amounts of stormwater enter the VCS. The exact size, number, and location have not been determined.

The structural separators will likely include a centrifugal chamber to encourage sedimentation of coarse solids and grit, followed by a floatable separation chamber to partially remove oils, grease, and floatable solid waste materials such as plastics. Because of capacity limitations of these systems, diversion weirs will be used on all large diameter high flow storm sewers to route initial first flush flows through a 24-inch line to the proposed separators. Smaller storm sewers will be routed directly to the proposed separator. Figure 3.05-5 presents an example of a structural separator. Details regarding structural stormwater treatment systems are included in Appendix F.

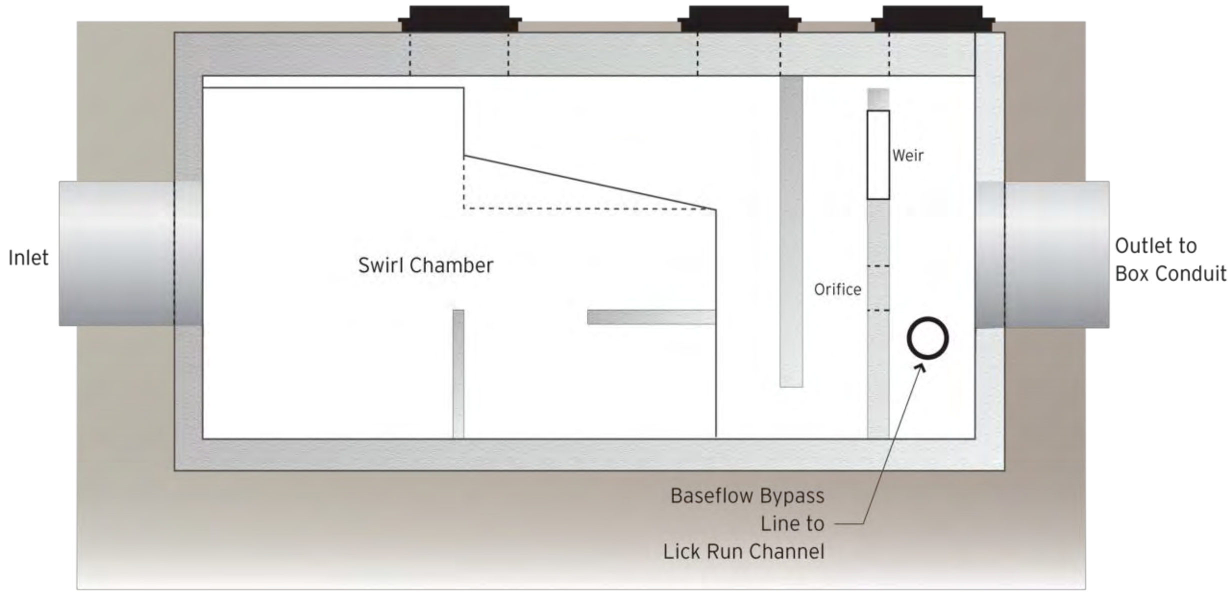


Figure 3.05-5 Structural Separator

F. BMPs–Open Water Forebay

Located on the west end of Queen City Avenue near the bypass, the open water forebay would receive first flush stormwater flows to remove pollutants such as floatable debris and high volumes of sediment. Flow will be diverted from the upstream subsurface box conduit into the forebay through a diversion structure and return to the downstream subsurface box conduit after traveling the length of the forebay. Figure 3.05-6 presents the open water forebay concept.

The discharge from the forebay will include a 12-inch base flow diversion pipe to allow treated base flow to be routed from the forebay to the headwaters of the proposed open channel to serve as a source of base flow in the open channel portion of the hybrid VCS. Flow from the forebay exceeding the capacity of the 12-inch base flow line will be routed back to the box conduit system. This 12-inch base flow diversion pipe and the subsurface box conduit extend approximately 1,000 linear feet from the forebay to the headwaters of the hybrid VCS located directly east of White Street.

It should be noted the area utilized for the forebay maximizes the available land area, given the adjacent roadway and utility constraints, and was not sized based on tributary drainage area. Depending on residence time, the forebay will provide trash and sediment removal and energy dissipation for stormwater flows before entering the channel. Depending on regulatory levels and water quality goals, other best management practices may be appropriate to consider for this area including a bioretention basin or constructed wetland that can provide additional water quality benefits.

Source: Human Nature, Inc.

Figure 3.05-6 Open Water Forebay Concept Plan

G. BMPs–Regional Online Stormwater Pond

An online wet stormwater pond has been incorporated immediately downstream of Harrison Avenue and upstream of State Avenue. The outfall of the 5-foot by 33-foot box conduit and open channel portions of the hybrid VCS will enter the west end of the stormwater pond. The pond will have a dry weather surface area of approximately 3.0 acres and will provide water quality benefits by allowing sediment and stormwater-borne pollutants to settle out. Approximately 90 percent of the Lick Run tributary area will be routed through the proposed online pond. As with the forebay, the area utilized for the regional online stormwater pond maximizes the available land area, given the adjacent roadway and utility constraints, and was not sized based on tributary drainage area. The online pond is expected to include a floating island to provide nutrient treatment through vegetative uptake. While the online wet stormwater pond was included in the hybrid VCS, this water quality feature could significantly change as the Master Plan for the central corridor is developed. Other water quality features considered for this area include various pond configurations or a large scale wetland to provide habitat enhancements and pollutant control.

3.06 BENEFITS

As mentioned previously in this section, the proposed storm sewers discussed in Section 2 will discharge to the proposed hybrid VCS. These two elements of the Wet Weather Strategy form an integrated, hydraulically connected system designed to remove stormwater from the existing CSS. Because of their connectivity, the utility and benefits of each element should not be considered independently in the context of their primary goal; i.e., CSO volume reduction. Therefore, the modeled benefits listed in Section 2.06 pertain to the hybrid VCS as well and are not repeated in this section.

3.07 VALUE ENGINEERING

The VE Study referenced in Section 2 also included opportunities to enhance the hybrid VCS concept. The opportunities recommended for further evaluation by the VE team, shown in italics, and a brief response to each are presented below.

A. *Use precast concrete boxes in lieu of the cast-in-place concrete box culvert*. CIP concrete boxes are typically constructed for less cost than precast boxes, but they require additional time for construction. As the design for these improvements is advanced, the implications of these two options should be further evaluated to determine if bid alternates would be warranted.

B. *Provide pools along the route of the open channel*. This recommendation will be evaluated further as the concept is finalized and design begins.

C. *Build the box culvert in a straight line and meander the open channel above.* The box conduit was intended to provide a stable bottom for, and efficient hydraulic interconnection with, the proposed open channel. Separating these two elements will compromise these objectives. Separation will also increase the cost to construct the box conduit as significant additional excavation and backfill would result; however, this recommendation will be evaluated further as the concept is finalized and design begins.

D. *Enhance the detention storage/water quality treatment capability upstream*. This recommendation will be evaluated further as the concept is finalized and design begins.

E. *Allow storm sewer to "leak."* This recommendation does not seem practical because of the current sequence of construction and regulations and specifications regarding the installation of new storm sewer.

F. *Seek advice from developers to determine development potential of cleared area*. The project team recommends engaging various entities during the process of defining the urban VCS to maximize community benefit and hydraulic functionality. From a development/revitalization perspective, this includes planners and developers.

G. *Define a mix of development that maximizes the value of the investment*. See response above.

H. *Provide water treatment for all hardscape surfaces in the riparian area.* This recommendation will be evaluated further as the concept is finalized and design begins.

I. *Capture and reuse rainwater in developable area and non-priority areas.* This recommendation will be evaluated further as the concept is finalized and design begins.

J. *Provide open space for future water quality BMPs.* This recommendation will be evaluated further as the concept is finalized and design begins.

K. *Develop "green streets" along streets that are being disturbed for other purposes*. This recommendation will be evaluated further as the concept is finalized and design begins.

L. *Explore transportation options at a neighborhood scale*. The design team recommends engaging various entities during the process of defining the urban VCS to maximize community benefit as well as hydraulic functionality. From a transportation perspective, this includes CDOTE and OKI.

M. *Daylight the stream starting at Grand Avenue and create a wetland to the east*. This approach reduces opportunities to maintain existing recreational opportunities within the corridor. Not withstanding these limitations, this approach could be included along with the various design concepts for the channel area as they are advanced through the public involvement process.

N. *Improve streetscaping*. This recommendation will be evaluated further as the concept is finalized and design begins.

O. *Add BMPs to natural drainage network to slow down the flow of the storm water*. This recommendation will be evaluated further as the concept is finalized and design begins.

P. *Provide a large storm water pipe with two combined sewer pipes on each side*. Reviewing agencies have expressed concern regarding the implementation risks associated with converting existing combined sewers to storm sewers. In addition, the capacity of the existing CSS is uncertain. As a result, this recommendation was not selected for further evaluation.

Q. *Use the existing combined sewer system for storm water and construct a new combined sewer system for non-priority areas and other sources in priority areas*. See above.

R. *Optimize storm water flow through the water channel without compromising safety*. This recommendation will be evaluated further as the concept is finalized and design begins.

S. *Revise the configuration of the box culvert to facilitate maintenance*. This recommendation will be evaluated further as the concept is finalized and design begins.

T. *Provide a geomorphologically appropriate channel to maximize habitat, water quality and public safety*. This recommendation will be evaluated further as the concept is finalized and design begins.

U. *Use an open channel with sewer pipes located on each side in lieu of the concrete box culvert below it*. The box conduit was intended to provide a stable bottom, and efficient hydraulic interconnection with the proposed restored channel area. Separating these two elements will compromise these objectives.

3.08 IMPLEMENTATION CONSIDERATIONS

A. Water Quality Regulations

Currently, most of the stormwater runoff from minor wet weather events (i.e., 0.5 inch or less) in the watershed is treated at the Mill Creek WWTP and is permitted under the current National Pollutant Discharge Elimination System (NPDES) permit for the Mill Creek WWTP. Upon implementation of the proposed sewer separation improvements and VCS, separated stormwater will discharge from the storm sewer system (MS4) to Mill Creek, requiring coverage under the City of Cincinnati's Phase II (NPDES) stormwater permit. The permit is administered by the OEPA and includes six minimum controls that must be addressed, including:

1. Public Education and Outreach
2. Public Involvement and Participation
3. Illicit Discharge Detection
4. Construction Site Runoff Control
5. Postconstruction Runoff Control
6. Pollution Prevention and Good Housekeeping Practices

Addressing these six minimum controls will likely be implemented via a watershed-wide stormwater management program that will evolve as planning and design of the project proceeds.

B. Ownership and Maintenance

MSD anticipates owning the land and the asset developed as a part of the Lick Run Wet Weather Strategy.

An effective maintenance program extends the useful life of stormwater controls and best management practices and helps to avert expensive repair costs and prevent problems downstream. Ideally, an open channel should be as self-maintaining as is feasible. However, given the constraints of the urban setting, the VCS will require routine care and maintenance in order to maintain efficient operation as well as a pleasing visual appearance consistent with a community amenity. Proposed structural separators, detention features, the online pond, and the open forebay will help to remove portions of heavier sediment and floatables, but these elements will require periodic maintenance themselves to be effective. The urban flow regime will also contribute to issues requiring periodic maintenance, including the removal of debris and solid waste as well as dealing with stream channel and bank erosion.

The hybrid VCS will also provide additional open space areas that will contribute to the aesthetic quality of the corridor but will require a significant level of routine conventional landscape maintenance in accordance with standards for these types of features including mowing, pruning, and general housekeeping.

C. Promoting Future Revitalization

Although the purpose of the Wet Weather Strategy is to benefit the CSS, it leverages MSDGC's *Communities of the Future* initiative to provide opportunities for sustainable revitalization within the entire watershed. Reconnecting natural systems to the city's core neighborhoods is a leveraged infrastructure investment, a catalyst for transportation improvements, commercial revitalization, employment and housing opportunities, and recreation improvements, that can build upon the short- and long-term sustainability of the watershed. While MSDGC supports and encourages the transportation improvements and revitalization opportunities, these elements are not part of the Wet Weather Strategy project. As the project progresses and the Master Plan for the VCS and central corridor is further defined, MSDGC, project stakeholders, and the community will need to work together to promote these initiatives.

SECTION 4
OPINION OF PROBABLE COST

4.01 INTRODUCTION

The primary elements of the Lick Run Wet Weather Strategy, including strategic sewer separation and an urban valley conveyance system, were discussed in detail in Sections 2 and 3. The costs for these elements are presented individually in this section, and then summarized for the entire Wet Weather Strategy at the end.

4.02 STRATEGIC SEWER SEPARATION OPINION OF PROBABLE COST

An initial opinion of probable construction cost (OPCC) for the strategic sewer separation element of the Wet Weather Strategy was developed in June 2010, subsequently updated in October 2010, and then again in later 2011. This OPCC was based on a preliminary 30 percent design and was developed using a unit price-based methodology for bid items. Unit prices were obtained from several sources including databases maintained by MSDGC and the Ohio Department of Transportation. Since the preliminary 30 percent design submittal in 2010, the sewer separation projects have been advanced to varying levels of design, incorporating various agency review comments. The associated costs in Table 4.02-1 are based on these current varying levels of design and the following key assumptions:

A. Minimum length of curb replacement was 10 feet.

B. Minimum length of sidewalk replacement was 5 feet.

C. Trench width was equal to pipe outside diameter plus 4 feet with a minimum trench width of 8 feet.

D. Coring to connect to existing structures was quantified independently.

E. Water main and gas main crossings were quantified.

F. Sanitary laterals were assumed to be relayed to the right-of-way line if the proposed storm pipe was the same elevation or slightly below the sanitary main.

G. Sheet piling was primarily considered within 10 feet of buildings and assumed to extend twice as deep as the proposed sewer.

H. Traffic signals were classified as major or minor depending on intersection geometrics, traffic volumes, and extent of proposed construction.

I. Utility poles within 2 feet of the trench limits were quantified as replaced.

J. Roadway restoration was based on existing pavement composition and restoration details provided by the City of CDOTE.

K. General conditions were included to account for miscellaneous items including jobsite supplies, construction management, maintenance of traffic, and bypass pumping.

L. Rock excavation was quantified separately and based on data from available soil boring logs.

M. Pipes removed from service were quantified as removed if larger than 24 inches and were quantified as filled, sealed, and abandoned if less than or equal to 24 inches.

Table 4.02-1 lists the construction costs and capital costs for each proposed project at its current level of design, as of December 30, 2011. For the purposes of this report, preliminary 30 percent refers to the fall 2010 design and associated submittals, and intermediate 30 percent refers to official turnover design and associated submittals. The turnover process is described in more detail in Section 5. The current OPCC for the sewer separation projects is approximately $52 million, resulting in a capital cost of approximately $67 million. The capital cost includes approximately $1.3 million for easements and approximately $5.0 million for engineering fees as well as various other applied factors and contingencies in accordance with MSDGC estimating guidelines.

Project Name	Construction Cost	Capital Cost	Design Level
Sunset Avenue, Sunset Lane and Rapid Run Pike	$7,679,000	$8,772,000	Intermediate 30 percent
Rapid Run ESP	$1,368,000	$1,469,000	Intermediate 30 percent
Wyoming and Minion Avenues	$2,233,000	$3,904,000	Intermediate 30 percent
Harrison Avenue Phase A	$1,973,000	$2,206,000	100 percent
Harrison Avenue Phase B	$1,114,000	$1,198,000	Intermediate 30 percent
State Avenue	$1,604,000	$1,995,000	Preliminary 30 percent
White Street	$3,669,000	$3,940,000	Intermediate 30 percent
Quebec Road	$4,744,000	$5,137,000	Intermediate 30 percent
Queen City Avenue Phase 2	$6,917,000	$12,305,000	Intermediate 30 percent
Queen City and Cora Avenues	$2,738,000	$4,858,000	Intermediate 30 percent
Quebec Heights Phase 1	$2,285,000	$2,602,000	Intermediate 30 percent
Quebec Heights Phase 2	$378,000	$495,000	Preliminary 30 percent
Grand and Selim Avenues	$4,843,000	$6,163,000	Preliminary 30 percent
Queen City Avenue Phase 3	$2,688,000	$3,517,000	Preliminary 30 percent
Westwood Avenue	$3,337,000	$4,171,000	Preliminary 30 percent
Queen City Avenue Phase 1	$3,903,000	$4,207,000	Intermediate 30 percent
TOTAL	**$51,473,000**	**$66,939,000**	

Table 4.02-1 Sewer Separation Projects Opinions of Probable Cost

As a part of MSDGC's standard project design submittal process, the Cost Estimating Group prepares an independent cost estimate for comparison to the OPCC prepared by the Design Consultant for the 30, 60, and 90 percent design submittals. If costs developed by both parties fall outside of a 10 percent range, then a reconciliation meeting is held between MSDGC Cost Estimating and the Design Consultant to determine what factors may be causing the discrepancies. Modifications are then made and the reconciled costs become those of record.

As a part of MSDGC's standard project design submittal process, the Cost Estimating Group prepares an independent cost estimate for comparison to the OPCC prepared by the Design Consultant for the 30, 60, and 90 percent design submittals. If costs developed by both parties fall outside of a 10 percent range, then a reconciliation meeting is held between MSDGC Cost Estimating and the Design Consultant to determine what factors may be causing the discrepancies. Modifications are then made and the reconciled costs become those of record.

Of the sewer separation project areas, Harrison Avenue Phase A is the only project that has formally gone through a reconciliation process. As a part of this project's 90 percent design submittal, costs were reconciled with MSDGC's Cost Estimating group in early November 2011 and are reflected in the cost presented previously in Table 4.02-1. The remaining sewer separation projects have been reviewed by MSDGC's Cost Estimating group as a part of the preliminary 30 percent submittal; however they will not be reconciled (only if necessary) until a final 30 percent design and OPCC are submitted by the Turnover Design Consultants.

4.03 VALLEY CONVEYANCE SYSTEM OPINION OF PROBABLE CONSTRUCTION COST

An OPCC was developed for the hybrid VCS in July 2010 for the current level of design. The same methodology and unit price sources were used for both elements where applicable. The OPCC for the hybrid VCS is divided into basic components and recommended enhancements follow.

A. <u>Basic VCS components</u>

1. Box conduit/Channel System from forebay to Mill Creek outfall, with limestone low flow channel and flood control channel.
2. Forebay area.
3. Online stormwater pond.
4. Vehicular bridge crossings (6)
5. Site, road and terrace restoration.
6. Utility relocations.
7. Retaining walls.
8. Base flow recirculation system.

B. <u>Recommended enhancements to the basic components</u>

1. Multi-purpose trail system and lighting.
2. Reforestation, landscaping and irrigation system.
3. Trail head parking.
4. Headwater feature and wetland areas.
5. Public Gardens. Picnic grove.
6. Promenade Concrete Walk.
7. Playground and recreational fields.
8. Site furnishings and drinking fountains.
9. Shelter.
10. Small scale pedestrian bridges.

The current OPCC for the hybrid valley conveyance system is approximately $67 million, resulting in a capital cost of approximately $97 million. The capital cost includes approximately $14.1 million for property acquisition and approximately $6.7 million for engineering fees, as well as various other applied factors and contingencies in accordance with MSDGC estimating guidelines. A breakdown of the OPCC is shown in Table 4.03-1.

Work Group		Construction Cost
Roadway Restoration	$	3,773,436
Utility Relocations	$	230,886
Site and Terrace Restoration	$	1,559,452
Lighting, Signage & Traffic Control	$	515,100
Retaining Walls	$	1,014,947
Bridges	$	5,211,812
Hybrid Conveyance System	$	28,606,663
Enhancements	$	12,305,211
Best Management Practices	$	2,460,000
Sub Total	$	55,677,508
20% Contingencies	$	11,135,502
TOTAL CONSTRUCTION COST	**$**	**66,813,010**
TOTAL CAPITAL COST	**$**	**96,947,284**

Table 4.03-1 Valley Conveyance System Opinion of Probable Cost

4.04 LIFE CYCLE COST ANALYSIS

In October 2010, a life cycle cost analysis was performed to develop a baseline for comparison to other potential CSO control projects that may be implemented to meet the requirements of the Consent Decree. The life cycle cost analysis accounted for construction costs, operations and maintenance, and replacement costs. Because the anticipated operations and maintenance costs are not expected to change significantly as a result of potential design revisions, the total operations and maintenance cost developed in October 2010 can be applied to the current OPCC to obtain an updated life cycle cost. This analysis indicated the present value of the 100-year operations, maintenance, and replacement costs for the Wet Weather Strategy was approximately $20 million.

The June 2008 *Metropolitan Sewer District of Greater Cincinnati Financial Analysis Manual* served as the basis for the life cycle cost analysis. This document provides consistency among the expected capital investment costs for all of MSDGC's projects. In addition to the initial capital cost associated with construction of a project, the financial analysis considers useful life expectancy for the capital assets and operation and maintenance costs as well. Cash flow techniques are utilized to determine the 100-year life cycle cost and present value.

Detailed costs are included in Appendix G.

SECTION 5
ADVANCEMENT OF LICK RUN WET WEATHER STRATEGY

5.01 REGULATORY COORDINATION PROCESS

Phase 1 of the WWIP developed by MSDGC, and submitted in June 2009, includes the LMCPRP, which specifically consists of 7,600 linear feet of 30-foot-diameter deep tunnel from Mill Creek WWTP to CSO 005, 2,000 linear feet of 7-foot-diameter consolidation sewer from CSO 005 to CSO 009, and an Enhanced High Rate Treatment (EHRT) facility with a capacity to treat 84 MGD. However, Phase 1 also includes a three-year study and design period to examine alternative measures. Following this three-year study and design period, a “Revised LMCPRP” may be submitted to the regulators as long as the proposed revisions provide an equal or greater level of CSO control and are able to be completed by the Phase 1 end date of December 31, 2018. The Revised LMCPRP must then be submitted by December 31, 2012.

The Lick Run Wet Weather Strategy described in this report is one of several projects anticipated to be included in the Revised LMCPRP. The planning and design efforts completed to date, and the advancement of the sewer separation projects and urban VCS described subsequently, will form the basis for the Lick Run Wet Weather Strategy portion of the Revised LMCPRP.

5.02 SEWER SEPARATION PROJECT TURNOVER

Reference to MSDGC’s turnover process was made in Section 2.08.A and is described in more detail here. The purpose of this process is to transition the sewer separation projects from the preliminary engineering and design team (MSDGC Environmental Program Department and consultants) to the detailed design team (MSDGC Project Delivery Department and consultants). This effort involves addressing review comments received on the preliminary 30 percent drawings submitted in fall of 2010, preparing a technical design memorandum, and updating the modeling, drawings, and OPCC for turnover to the detailed design team. Collectively, the technical design memorandum and updated modeling, drawings, and OPCC comprise the turnover documents. A project turnover meeting is then held with utility representatives, stakeholders, and all members of the project team including those who will be completing detailed design. Comments and change requests at the meeting are incorporated into the final turnover documents, which are officially submitted to complete the turnover process.

As of December 30, 2011, four sewer separation projects have been through MSDGC’s turnover process or advanced to final design. Of the ten remaining projects, the turnover process for four of the projects has been initiated, three projects are anticipated to be included in the design and construction of the urban VCS, and three projects are not anticipated to go through the turnover process. Table 5.02-1 summarizes the current status of the sewer separation projects.

Project Name	Project ID	Status
Sunset Avenue, Sunset Lane and Rapid Run Pike	11240010	Turnover meeting held on June 1, 2011
Wyoming and Minion Avenues	11240030	Turnover meeting anticipated in early 2012
Harrison Avenue Phase A	11240050	Final design complete, bid anticipated in early 2012
Harrison Avenue Phase B	11240050	Turnover meeting held on July 13, 2011
State Avenue	11240070	Preliminary 30 percent design complete, no turnover–included with urban VCS
White Street	11240090	Turnover meeting held on July 13, 2011
Quebec Road	11240110	Turnover meeting anticipated in early 2012
Queen City Avenue Phase 2	11240130	Turnover meeting anticipated in December 2011
Queen City and Cora Avenues	11240150	Preliminary 30 percent design complete, no turnover–natural conveyance
Quebec Heights Phase 1	11240170	Preliminary 30 percent design complete, no turnover–natural conveyance
Quebec Heights Phase 2	11240190	Preliminary 30 percent design complete, no turnover–natural conveyance
Grand and Selim Avenues	11240210	Turnover meeting anticipated in early 2012
Queen City Avenue Phase 3	11240230	Preliminary 30 percent design complete, no turnover–included with urban VCS
Westwood Avenue	11240250	Preliminary 30 percent design complete, no turnover–included with urban VCS
Queen City Avenue Phase 1	11240270	Turnover meeting held on August 31, 2011

Table 5.02-1 Current Status of Sewer Separation Projects

The Queen City Avenue Phase 3, State Avenue, and Westwood Avenue projects are expected to be grouped with the urban VCS for two reasons. First, the projects together would require eight temporary connections, which should be minimized or avoided, if possible. Second, the projects are located in proximity to the urban VCS; therefore, project costs, maintenance of traffic and neighborhood disturbance would be minimized by consolidating the construction.

The Quebec Heights Phase 1, Quebec Heights Phase 2, and Queen City and Cora Avenues projects are not expected to advance through the turnover process. As previously stated, the turnover process facilitates the transition of projects between design teams. In the case of these three projects, it is expected they will remain within the Environmental Program Department through final design because they involve natural conveyance and sustainable infrastructure techniques; therefore, the turnover process is unnecessary.

The sewer separation projects already through the turnover process are currently at varying levels of design and will advance on different schedules. While this is to be expected, it should be noted that continued coordination between the preliminary engineering design teams and the detailed design teams will be required to successfully complete the design and construction of these projects. Currently, construction of all sewer separation projects is anticipated to be finished by the end of 2016.

5.03 VCS COORDINATION WITH LICK RUN MASTER PLAN

Input from the local community, neighborhood groups, associations, and stakeholders will be critical in shaping the Lick Run Wet Weather Strategy included in the Revised LMCPRP submitted to the regulators at the end of 2012. With the goal of refining the urban VCS concept and maximizing the potential for other long-term community benefits and amenities, MSDGC is hosting a series of interactive "Community Design Workshops." The outcome of the workshops will be summarized in a Lick Run Master Plan centered around the concept for the urban VCS. It is anticipated that the Lick Run Master Plan will be complete in March of 2012.

A. Community Design Workshop No. 1

This workshop was held on August 11, 2011. During four breakout sessions, participants provided MSDGC with valuable input through visual preference surveys, questionnaires, and discussion. The four breakout sessions covered the following topics:

1. The Open Space Corridor (focusing on the proposed urban VCS corridor in South Fairmount).
2. The Community Core (focusing on the South Fairmount business district).
3. The Historic Fabric (focusing on historical and cultural resources in the community).
4. Hillsides and Ridgetop Neighborhoods (focusing on the entire Lick Run watershed).

B. Community Design Workshop No. 2

This workshop, held on October 26, 2011, featured an overview presentation and small group work sessions to review and discuss design concepts for the proposed urban waterway in South Fairmount. The workshop also covered transportation network opportunities, green planning principles, and trail network opportunities. All concepts were developed with input from Community Design Workshop No. 1.

C. Community Design Workshop No. 3

The information from the first and second workshops will be used to prepare a preliminary Lick Run Master Plan for presentation at Community Design Workshop No. 3 anticipated in February 2012. The Master Plan will contain the refined design concept for the urban VCS as well as future guidelines and planning principles for the entire watershed.

Upon completion of the Lick Run Master Plan, the urban VCS will move into the design phase. More detail on the design and construction schedule is provided in Section 3.08.

5.04 CSO REDUCTION ELEMENTS OF THE LICK RUN WET WEATHER STRATEGY

Section 1 listed six elements of the Wet Weather Strategy including strategic sewer separation, an urban VCS, reforestation, detention, small scale site-specific controls, and downspout disconnection. This report focused on strategic sewer separation and the urban VCS, but detention and site-specific controls are also discussed in Sections 2.05.B and 2.05.C, respectively.

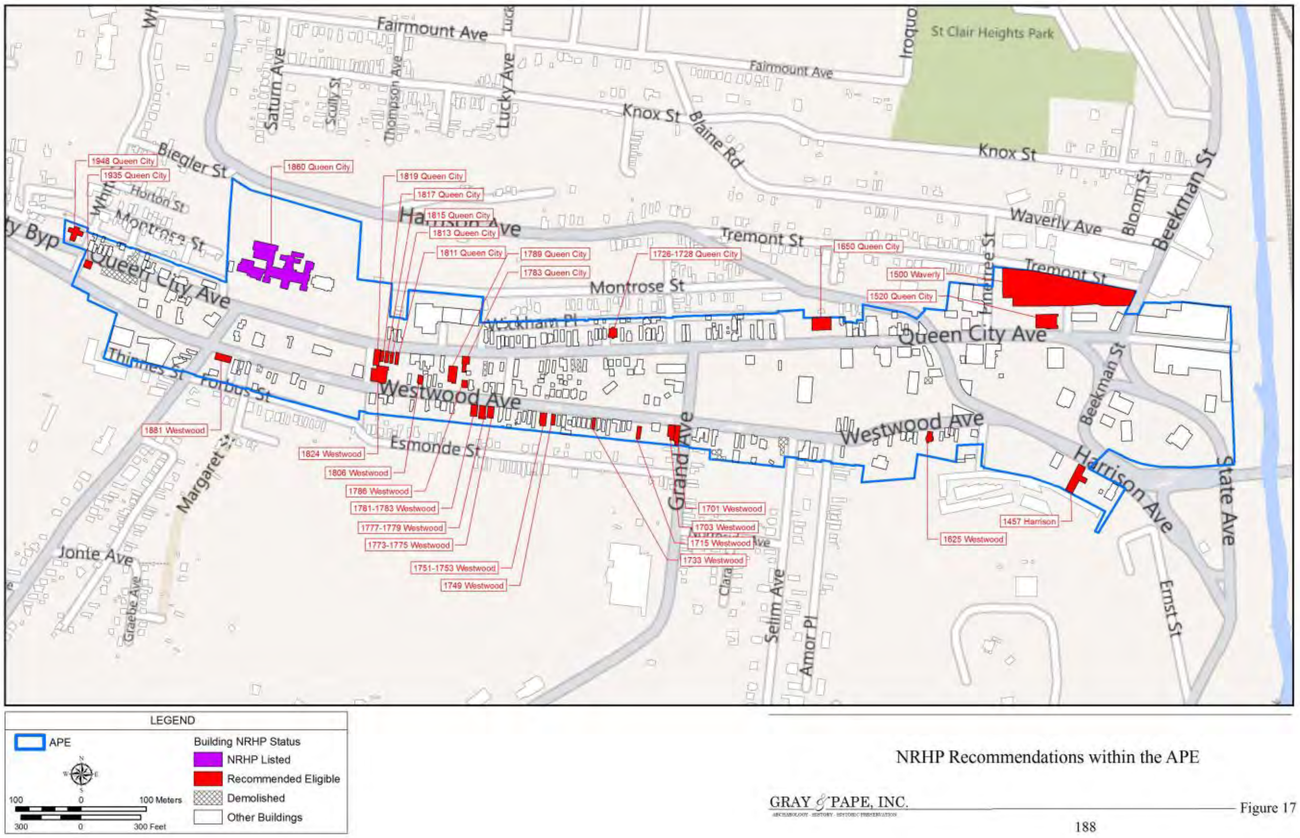
Modeling results indicate strategic sewer separation and the urban VCS can achieve the desired CSO reduction for the Lick Run Watershed. Reforestation and downspout disconnection are not anticipated to be additional quantitative measures that are included in the Wet Weather Strategy as presented to regulators at the end of 2012. Consequently, reforestation and downspout disconnection, which were proposed in the non-priority areas, are not specifically discussed in this report. However, these elements can be developed independently and represent opportunities for MSDGC to further reduce CSO volume from the Lick Run Watershed in the future.

5.05 LICK RUN WET WEATHER STRATEGY IMPLEMENTATION CONSIDERATIONS

A. Historical and Archaeological

Section 106 of the National Historic Preservation Act of 1966 requires that federal agencies take into account the effects of their undertakings upon for properties that are listed in or *eligible* for listing in the National Register of Historic Places (NRHP). A federal undertaking is defined as a project, program, or activity funded, permitted, licensed, or approved by a federal agency. It is anticipated that a USACE individual permit will be required for the connection of the proposed urban VCS to Mill Creek. As a result, a Section 106 review will likely be required for this project. The Section 106 compliance process normally entails consultation and coordination with the State Historic Preservation Officer (SHPO).

The project team is currently identifying and evaluating properties listed in, or eligible for listing in, the NRHP in anticipation of consultation with the SHPO and other agencies. Discussions with these agencies will likely commence following the completion of the Lick Run Master Plan. Figure 5.05-1 shows NHRP eligibility recommendations, as of December 30, 2011, in the urban VCS corridor.



Source: Gray & Pape, Inc.

Table 5.05-1 NHRP Recommendations

B. Hazardous Materials

A preliminary hazardous materials review was completed for the sewer separation project areas. A hazardous material screening sites location map and associated tables generated from the preliminary hazardous materials review are found in Appendix J. This review involved several sources of information including Sanborn Fire Insurance Maps, the Ohio Department of Commerce Bureau of Underground Storage Tank Regulations (BUSTR) database, the OEPA Licensed Municipal Solid Waste Landfill Facilities database, the USEPA Envirofacts Database Warehouse, and previously completed Phase I and Phase II Environmental Site Assessments (ESA). A Phase I area-wide ESA was also completed for the central corridor, as mentioned in Section 1, identifying properties potentially requiring a Phase II. Various Phase II investigations have been advanced throughout the VCS corridor as a part of the property acquisition efforts. MSDGC has applied for and received a Clean Ohio Grant for a public piece of property located east of State Avenue.

C. Property Acquisition and Easements

A number of properties and easements will need to be acquired to construct the urban VCS and associated utility improvements. The specific properties required for the VCS will not be identified until the Lick Run Master Plan is complete and a preferred concept is identified. A preliminary property acquisition plan was developed for the VCS corridor, as discussed in Section 1, and to date MSDGC has been evaluating and acquiring properties in this corridor on a case-by-case basis.

The proposed storm sewer projects will require temporary and permanent easements to complete construction and maintain the assets once installed. Although preliminary easements were identified to develop cost opinions for the sewer separation projects, the limits of these easements will be refined once the alignment of the proposed storm sewers is finalized.

D. Traffic Maintenance

Construction of the proposed improvements will disrupt traffic movement throughout the entire urban VCS and sewer separation project areas. To minimize this disruption, it will be critical to maintain connectivity on Westwood and Queen City Avenues' one-way pair corridor during construction. This corridor provides an important linkage between the west side of Cincinnati and the downtown area for nearly 55,000 vehicles per day using the Western Hills Viaduct. It will also be critical to maintain local access to business and residences in the corridor wherever possible.

Coordination with project stakeholders, notably CDOTE, will be essential in developing an effective maintenance of traffic (MOT) plan. The objective of this plan will be to provide for the safe and efficient movement of vehicles, bicyclists, and pedestrians through or around construction zones while protecting the construction workers and allowing efficient construction and maintenance of the roadway. It is anticipated that the MOT will incorporate a staged construction approach to minimize road closures and allow for efficient detours. The plan will also identify signage and barricades to effectively communicate detour routes to the motoring public. Impacts to signalized intersections will need to be analyzed so that appropriate temporary signal timing and phasing can be implemented during construction. Part 6 of the *Ohio Manual of Uniform Traffic Control*, developed by ODOT as a standard for all traffic control devices, should serve as a guidance document to develop the MOT plan.

E. Permitting

Coordination with federal, state, and local agencies will be an important component of the proposed project. Necessary permits and coordination with regulatory agencies were discussed in the PEA, and potential regulatory programs for the Lick Run project were identified in October 2010. Table 5.05-1 presents potential regulatory programs including the permit/authorization name and description, necessary information to be submitted, expected agency review time, and agency contact information.

The project team has held coordination meetings with the USACE, OEPA, and local agencies to discuss permitting on a watershed-wide basis and develop a procedure for future submittals. To date, one permit-to-install application has been submitted to the OEPA for the Harrison Avenue Phase A sewer separation project. This application was approved by the OEPA in the fall of 2011.

TABLE 5.05-1

SUMMARY OF PERMITTING INFORMATION

Permit/Authorization Name and Description	Required Information	Expected Agency Review Time	Contact Information
US Army Corps of Engineers (USACE) 404 Individual Permit. Required to discharge to the Mill Creek 33 CFR 320 to 330.	Project description. Project purpose and nature of the activity. Plans and cross sections.	6 to 8 months	United States Army Corps of Engineers–Louisville District Permits (Regulatory) Operations Division P.O. Box 59 Louisville, KY 40201-0059 502-315-6678
Federal Highway Administration (FHWA) No permit required.	Coordination with FHWA as required by NEPA.	N/A	Federal Highway Administration Ohio Division 200 North High Street, Rm 328 Columbus, OH 43215-2408 614-280-6896
US Fish and Wildlife Service (USFWS) No application.	Scan/review/gather information for other permits. Letter to USFWS requesting an endangered species consultation.	Indeterminate	U.S. Fish and Wildlife Service Ecological Services 6950-H Americana Parkway Reynoldsburg, OH 43068-4115 614-469-6923
Federal Emergency Management Agency (FEMA) Construction or development within any Special Flood Hazard Area (SFHA).	Verify 100-year floodplain locations. General project description.	Indeterminate	Federal Emergency Management Agency National Flood Insurance Program U.S. Department of Homeland Security 500 C Street SW Washington, D.C. 20472 www.fema.gov/business/nfip/
United States Environmental Protection Agency (USEPA) No permit. Renovation, Repair, and Painting (RRP). Pertains to lead-based paint.	Number of homes to be demolished built before 1978. Training certificate of the contractor. Results from inspection.	N/A	National Lead Information Center 422 South Clinton Avenue Rochester, NY 14620 800-424-5323 www.epa.gov/lead/pubs/renovation.htm

Permit/Authorization Name and Description	Required Information	Expected Agency Review Time	Contact Information
Ohio Environmental Protection Agency (OEPA) Permit to Install (PTI) for Water and Sewer. Section 401 Water Quality Certification (WQC).	Notice of Intent (NOI). Water main relocations and sanitary sewer extensions. Discharge or surface water modifications. Coordinate need anticipated based on design options to modify waters/water flow.	3-6 months With USACE permitting.	Ohio Environmental Protection Agency–Southwest District 401 East Fifth Street Dayton, OH 45402 614-644-2782 www.epa.state.oh.us/dsw/401/WQC.aspx
Ohio Environmental Protection Agency (OEPA) **Department of Health** Building demolition: asbestos National Emission Standard Hazardous. Air Pollutants–NESHAP 40 CFR Part 61, Subpart M.	Complete facility description. Description of planned demolition or renovation work to be performed and methods employed and time frame for demolition. Any asbestos (including type) present at the site. Procedures used to detect asbestos. Scheduled hours of operation. Contact information for waste transporters. Identification of the disposal site for the material. Certification that NESHAP-trained person will be available at site.	Submit at least 10 working days before operations begin.	Ohio Environmental Protection Division of Air Pollution Control P.O. Box 1049 Columbus, OH 43216-1049 614-644-2270 www.epa.ohio.gov/dapc/atu/asbestos/asbestos.aspx
Ohio Environmental Protection Agency (OEPA) National Pollutant Discharge Elimination System (NPDES). Permit for Mill Creek WWTP. National Pollution Discharge Elimination System Phase II stormwater permit.	According to sewer separation, address the six minimum controls in accordance with the City of Cincinnati Phase II stormwater permit.	NOI should be submitted at least 21 days prior to the start of construction.	Ohio Environmental Protection Agency P.O. Box 1019 Columbus, OH 43216-1049 614-644-2001 www.epa.state.oh.us/dsw/permits/permits.aspx
Ohio Environmental Protection Agency (OEPA) National Pollutant Discharge Elimination System (NPDES) construction general permit (OHC000003).	Proposed improvements associated with the main channel construction for post-construction BMP implementation.	Indeterminate	Mike Joseph Division of Surface Water–Stormwater Section P.O. Box 1049 Columbus, OH 43216-1049 614-752-0782

Permit/Authorization Name and Description	Required Information	Expected Agency Review Time	Contact Information
Ohio Department of Transportation (ODOT) Right-of-Way User Permit.	Coordinate to determine if any right-of-way coordination is needed. General project information. Dimensions and locations of buildings, right-of-ways, and accesses.	Submit at least 24 hours prior to starting any work.	Ohio Department of Transportation 505 South Street, Route 741 Lebanon, OH 45036 513-932-3030
Ohio Department of Natural Resources (ODNR) Erosion Control Permit, as applicable.	General project information. Stormwater Management Practices used.	Indeterminate	Division of Soil and Water Resources 2045 Morse Road Building B-3 Columbus, OH 43229 614-265-6610
Ohio Historical Preservation Office (OHPO) No permit required. Must follow 106 requirements for historical and archeological areas.	Coordination with historical/archeological consultant may be required.	N/A	Ohio Historical Society 1982 Velma Avenue Columbus, OH 43211 614-297-2300 www.ohiohistory.org/resource/histpres/
Railroad No permit required.	Project description. Coordination efforts needed.	N/A	
City of Cincinnati No permit required. Environmental Justice ordinance and other applicable ordinances should be followed.	Contact about potential subway tunnels. Ongoing coordination of the project. Demonstration that health problems for the surrounding communities will not be caused.	N/A	Office of Environmental Justice Larry Falkin 513-352-5323 www.cincinnati-oh.gov/cmgr/pages/-17684-/
Cincinnati Park Board–Urban Forestry Tree removal within the right-of-way. Chapter 743 of the Cincinnati Municipal Code.	General project information. Proposed work to be done including number of trees removed and proposed. Utilities present within 15 feet of the trees Project cost.	Submit this permit after CDOTE street opening permit. 15 days	Urban Forestry 3215 Reading Road Cincinnati, OH 45229 513-861-9070 www.cincinnati-oh.gov/cityparks/pages/-4448-/

Permit/Authorization Name and Description	Required Information	Expected Agency Review Time	Contact Information
City of Cincinnati Water Works Building permit.	General project information. Overall site plan.	Indeterminate	City of Cincinnati Water Works Engineering Division 4747 Spring Grove Avenue Cincinnati, OH 45232-1986 513-591-7859 www.cincinnati-oh.gov/water/pages/-13028-/
City of Cincinnati Department of Transportation & Engineering Hamilton County Engineer Open pavement and excavation work.	General project information. Plan set and documentation. Amount of pavement affected.	10 to 12 weeks for review. Notify 48 hours before starting construction.	Department of Transportation & Engineering Permit & License Center City Hall, Room 425 801 Plum Street Cincinnati, OH 45202-1980 513-352-3463 www.cincinnati-oh.gov/transeng/pages/-7297-/ Hamilton County Engineer's Office 223 West Galbraith Road Cincinnati, OH 45215 513-946-8430 http://www.hamiltoncountyohio.gov/Engineer/
Municipal Sewer District of Greater Cincinnati (MSDGC) Sewer Connection Credit policy.	Amount of stormwater removed. Amount of wastewater added.	Indeterminate	Municipal Sewer District Engineering Division 1600 Gest Street Cincinnati, OH 45204 513-244-1330
Municipal Sewer District of Greater Cincinnati (MSDGC) Tap Permit.	General project information. A licensed sewer tapper. Permission from Shawn Patton. Building permit issued from the municipality. Site plan.	Indeterminate	Municipal Sewer District Engineering Division 1600 Gest Street Cincinnati, OH 45204 513-244-1330 www.msdgc.org/customer_service/permits_records/

Permit/Authorization Name and Description	Required Information	Expected Agency Review Time	Contact Information
Stormwater Management Utility (SMU) Building Permit.	Three sets of plans and two sets of specifications, calculations, drawings, and other supporting data with a memo describing the proposed work. Drainage plan submittal. As-builts.	Indeterminate	Stormwater Management Utility 1600 Gest Street Cincinnati, OH 45204 513-557-7166
Ohio Utilities Protection Service (OUPS) No permit required.	Coordinate with local utilities during construction.	Coordination should occur at least 1 week before topographic survey and construction	Ohio Utilities Protection Service 800-362-2764 or 8-1-1 (excavation/digging request)